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A Rose by Naming: How We May Learn How to Do It

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Naming appears to be the source of the explosion in language development and involves the integration of the initially separate listener and speaker responses. This integration has a role in the development of reading, writing, and the following and construction of verbal algorithms that make types of complex human behavior possible. Considerable research has investigated the role of Naming in the emergence of derived relations. Recent research has also investigated the emergence of Naming itself. We describe these experiments and the experiences that function to induce Naming. We also describe evidence about preverbal developmental cusps that are foundational to the emergence of Naming and the evidence on its reinforcement sources. The isolation of the role of the environment in the emergence of Naming identifies stimuli that were said to be missing in accounts that were critical of Skinner's (1957) account of verbal behavior. These arguments purported that the phenomenon was not attributable to learning because of the ''poverty of the stimulus.'' Some of the relevant stimuli now appear to be identified.

Key words: naming, emergent verbal behavior, verbal developmental cusps, verbal developmental learning capabilities, incidental language learning

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What's in a Name? that which we call a rose
By any other name would smell as sweet

(William Shakespeare, *Romeo and Juliet*, Act II, Scene II, Lines 43 and 44, Clarke & Wright, 1952)

''Naming … (b) Naming of parts: the process of becoming acquainted, or of acquainting others with the essentials of an unfamiliar object or topic'' (*Oxford English Dictionary*, 2000, p. 206).

We will distinguish between this definition (i.e. naming in common usage) and the specialized usage of the term in the behavior analysis community by capitalizing the word. *Naming* is in essence naming, as defined above, but in the analysis of verbal behavior the integration of the behavioral processes involved is identified as a particular higher order verbal operant that is an important milestone in language development (Greer, 2008; Horne & Lowe, 1996).

Horne and Lowe (1996) first used the term *Naming* to describe a verbal developmental phenomenon and stage. When a child acquires Naming, hearing someone tact an object in the environment (e.g., ''shoe'') as the child and speaker observe the shoe results in the child learning to say the word *shoe* and also to respond to it as a listener, by looking at the shoe, pointing at the shoe, or wearing it. That is, on seeing the stimulus in the presence of a relevant audience, the child says, ''shoe.'' Also, if someone says ''shoe,'' the child looks at the shoe when a shoe is available. What constitutes a shoe may also include different types of shoes and other foot apparel. The child with Naming learns these responses without direct instruction. The notion of Naming, as proposed by Horne and Lowe (1996), provided a new theoretical perspective on the study of language as behavior, a focus introduced by Skinner (1957). Horne and Lowe emphasized that their Naming account built on Skinner's work by emphasizing the *speaker–listener relation* within the organism, or what Skinner referred to as *speaker-as-own- listener*. They proposed that Naming was the beginning of being truly verbal, because it fused the listener and speaker functions. Interestingly, relational frame theorists, who have a different perspective on verbal behavior, agree with the Naming theorists on the centrality of the Naming function to being fully verbal (Barnes-Holmes, Barnes-Holmes, & Cullinan, 2001). It also appears that Skinner regarded the speaker-as-own-

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listener as key to the advancement of a science of verbal behavior as he stated, ''We need separate but interlocking accounts of the behaviors of both speaker and listener if our explanation of verbal behavior is to be complete … in many important instances the listener is also behaving at the same time as a speaker'' (p. 34).

Drawing on recent research and the verbal developmental theory (Greer & Ross, 2008; Greer & Speckman, 2009), we build on Horne and Lowe (1996) and Skinner (1957). However, we emphasize an aspect of Naming that seems to have been overlooked. That is, Naming appears to be *a*, or *the*, crucial stage in children's verbal development, a stage that makes it possible for children to come to learn language incidentally. Furthermore, it is foundational to more advanced verbal development, including learning to read and write effectively. Horne and Lowe elaborated on how Naming leads to the development of other functions of verbal behavior, such as intraverbals. We do not repeat the progression they described; we agree with that progression and add to it. If Naming is the source of learning language incidentally, and we will cite evidence that it is, how children come to learn language incidentally is of interest to verbal behavior analysis, developmental psychology, current linguistic theory, neuroscience, and a science of pedagogy.

Horne and Lowe (1996) provided an empirically testable definition of what is entailed when Naming acquaints one with the ''essentials of an unfamiliar object or topic'' from the perspective of both verbal functions: the functions of the speaker and the listener. They described this as the fusion of speaker and listener within the individual. Naming is the fusion, joining, or integration of the listener and speaker repertoires of human behavior (Greer & Speckman, 2008; Lodhi & Greer, 1989; Skinner, 1957). How this fusion occurs is a topic of interest to verbal behavior development within the life span of the individual.

Naming is one of the three types of speaker-as-own-listener behaviors that have been identified experimentally: (a) Naming (e.g., Greer, Stolfi, Chavez-Brown, & Rivera-Valdes, 2005), (b) self-talk involving rotating speaker and listener responses aloud (e.g., Lodhi & Greer, 1989), and (c) correspondence between saying and doing (e.g., Paniagua & Baer, 1982; Rogers-Warren & Baer, 1976). Lodhi and Greer suggested that it might be possible to identify speaker-as-own-listener conversational units (what Skinner originally referred to as *verbal episodes*) when a young child rotates the speaker and listener roles during solitary play. Lodhi and Greer demonstrated that typically developing 5-year-olds emitted distinct speaker and listener responses as they talked aloud to themselves while playing. Paniagua and Baer and Rogers-Warren and Baer demonstrated correspondence between what children said and what they did, also suggesting the fusion of the listener and speaker repertoires.

Each of these types of speaker-as-own-listener repertoires are important and probably interrelated, but in this paper we focus on Naming as a key developmental stage. We argue that when children acquire Naming, their language expands exponentially from incidental observation. It is not only that after learning the tact one can respond as a listener; rather, after particular experiences, children with Naming learn both of these repertoires without direct instruction. Considerable evidence suggests that at around 3 years of age the vocabulary of typically developing children expands exponentially and is often referred to as an *explosion in vocabulary* (Hart & Risley, 1995, 1999; Kinneally, 2007; McGuiness, 2004, 2005). Hart and Risley found that little of this vocabulary explosion was attributable to direct instruction. Thus, much of children's vocabulary is acquired incidentally. Current evidence (Fiorile & Greer, 2007; Greer, Stolfi, et al., 2005; Greer, Stolfi, & Pistoljevic, 2007) supports the notion that the mechanisms for children's learning of words for things incidentally is, in fact, traceable to instructional histories and the ensuing stimulus control that lead to Naming as *a*, or *the*, source of incidental language learning.

A child with Naming can acquire new verbal behavior as a result of certain encounters with the environment that we will call *Naming experiences*. A Naming experience occurs when a child and a caregiver are simultaneously looking at, or in some other way sensing, a stimulus (referred to by developmental psychologists as joint attention; Crystal, 2006) as a caregiver produces a

vocal or signed response in the presence of a stimulus (e.g., an object). In vocal verbal behavior, the acquisition of Naming for a stimulus requires both the auditory stimulus of the word that is spoken by the caregiver and the child attending to another feature of the stimulus (e.g., looking at the rose, smelling the rose, touching the rose). Multiple controls are learned (Skinner, 1957). The child may smell a rose as the speaker says, ''This is a rose.'' The child may touch the rose as the speaker does so and says ''rose.'' It is not impossible that the child and speaker may taste the rose petal as the speaker says ''rose.'' Certain emotional effects accrue along with these sensory experiences (e.g., the child may prick his or her finger or delight in the scent). After these kinds of experiences, the child says ''rose'' when seeing a rose (an abstraction is involved here, as in the case of different colors and types of roses, unless it is the very same rose). Also, if the child is asked, ''What is this?'' by a speaker referring to a rose, the child responds with an intraverbal tact (i.e., ''it's a rose,'' responding to the auditory stimulus along with other sensory stimuli). In addition to these two types of speaker responses, the child may orient or look at a rose as someone says, ''rose'' or ''I see a rose,'' or the child may point to a rose in an array of different flowers when a speaker asks the child to point to a rose. Also the child may ''see'' the rose through the mind's eye, or what Skinner (1957) referred to as *conditioned seeing*. These latter instances are examples of the speaker and listener bidirectional components of Naming (Catania, 2007). Not only does the Naming experience result in multiple stimulus control, but it also results in multiple responses: the response of the speaker and the response of the listener. The speaker response need not be vocal, consistent with Skinner's treatment of verbal behavior. That is, the speaker response, described as a *production response* in linguistics, may be signs (e.g., sign language, logographic symbols, or Morse code), but we think that the speaking voice has special utility, as we will show below.

The incidental acquisition of language by children is a well-observed human phenomenon and is regarded as a unique human characteristic. Plato is cited as proclaiming, ''Even in the infant the latent power of naming is almost immediately identifiable'' (*Oxford English Dictionary*, 2000, p. 206). The acceptance of this phenomenon as a ''latent power'' is reiterated over 2,000 years later in some contemporary accounts as an innate language capability; one that evolves independently of experience (Kineally, 2007; Pinker, 1999; Premack & Premack, 2003). Chomsky (1959) referred to this ''latent power'' as evidence of the lack of reinforcement and teaching, because there is a ''poverty of the stimulus'' (Chomsky & Place, 2000). However, for a basic science of behavior, the identification of the possible role of environmental experiences is a major objective. It is also a pragmatic problem for those who work to teach verbal behavior to individuals with language delays (e.g., children with autism spectrum disorders or pervasive developmental disabilities; Sundberg, 1998; Sundberg & Partington, 1998) and children who are economically disadvantaged and lack rich language experiences (Greer & Keohane, 2005/2006; Greer & O'Sullivan, 2007; Greer & Ross, 2008; Hart & Risley, 1995, 1999).

For those who have attempted to teach children who would not have talked (or used substitute productive language), each new speaker behavior often needs to be taught by direct reinforcement and correction. Similarly, learning to respond to the words as a listener requires separate direct instruction (Pistoljevic & Greer, 2006; Ross & Greer, 2003; Schauffler & Greer, 2006; Tsiouri & Greer, 2003; Williams & Greer, 1993). However, if Naming can be induced in children who are missing it, their verbal prognosis is exponentially enhanced, because they can learn both the listener and speaker functions incidentally by observation and without direct instruction from others. That is, Naming results in the exponential expansion of vocabulary, or more specifically, the joining of the listener and speaker functions for observed stimuli. It appears that learning a word–object relation in both the listener and speaker function constitutes what is referred to in lexicons as ''becoming acquainted … with the essentials of an unfamiliar object or topic'' (*Oxford English Dictionary*, 2000, p. 206). How histories of experience lead to

the capability to learn language incidentally is the focus of this paper.

NAMING IN VERBAL BEHAVIOR

Naming, as a developmental verbal behavior phenomenon, includes the process of labeling or tacting, as when one is said to say the ''name'' for something. A speaker sees an object and says a word that a particular community concurs to be the name of the object. For example, a child sees a bird and says ''bird.'' In addition, Naming also entails the ability to emit the listener response, as when a child responds to the spoken word as a listener by looking at or pointing at the relevant stimulus. For example, an adult in the presence of a bird says, ''see the bird,'' and the child looks at or points to the bird. According to Skinner (1957), this example of the adult's response is referred to as a type of speaker operant called the *tact*, if it has certain characteristics. Tacts involve saying or signing the word (a tact) in the presence of nonverbal visual, auditory, olfactory, or gustatory stimuli under the control of generalized social reinforcers. Although Naming includes the repertoire of emitting tacts and implicitly the echoic, the tact repertoire may occur earlier in children's development than the full Naming relation (Crystal, 2006; Hart & Risley, 1995; Horne & Lowe, 1996; McGuiness, 2004, 2005). Naming also requires the repertoire of differentially responding to vowel-consonant blends as a listener. That is, the child looks at or points to a bird when an adult says ''bird'' in the presence of a bird (Greer, Chavez-Brown, Nirgudkar, Stolfi, & Rivera-Valdes, 2005). Skinner describes the listener and the speaker as two initially independent repertoires, and there is evidence that these two repertoires initially develop independently during language development (Crystal; Greer et al., 2007; McGuiness). Other literatures refer to these as *expressive* and *receptive* functions, but Skinner and we eschew those terms. They imply that language is a central function with expressive and receptive qualities, whereas we believe them to be two independently evolved functions that are joined by cultural contingencies. However, after Naming develops, listener and speaker repertoires become joined or integrated in what initially were developmentally independent repertoires (Greer, 2008; Greer & Keohane, 2005/2006; Greer & Ross, 2004; Greer & Speckman, 2009; Greer et al., 2007; Horne & Lowe, 1996).

Before the listener and speaker are joined, mastery of the listener and speaker responses in the presence of the same stimulus requires separate and direct instruction. For example, if a child is taught to point to a stimulus while hearing its name (i.e., a color), he or she will not be able to say or tact the stimulus when shown it and asked, ''What is it?'' However, when Naming is present, when the child has observed someone tacting a stimulus, he or she can emit both speaker and listener responses (Horne, Hughes, & Lowe, 2006; Horne & Lowe, 1996; Horne, Lowe, & Randle, 2004; Lowe & Beasty, 1987; Lowe, Horne, Harris, & Randle, 2002; Lowe, Horne, & Hughes, 2005). When one has Naming, direct instruction for either the speaker or listener response separately results in the emission of the untaught response without instruction. And even more interesting from a developmental perspective, the child can also emit both responses without direct instruction or observation of others being instructed. It is a bidirectional relation (Catania, 2007) that originates from special observational experiences and the instructional histories that allow a child to contact those observed experiences.

Naming As an Independent Variable

For two decades, behavior analysts have studied the potential of Naming with respect to how it may or may not facilitate certain emergent categorization (Arntzen, 2004; Clayton & Hayes, 1999; Dugdale & Lowe, 1990; Fields et al., 2003; Guess & Baer, 1973; Hayes, 1989; Hayes, Barnes-Holmes, & Roche, 2001; Horne et al., 2004, 2006; Keller & Bucher, 1979; Lee, 1981; Lowe & Beasty, 1987; Miguel & Petursdottir, 2009; Miguel, Petursdottir, Carr, & Michael, 2008; Randell & Remington, 2006; Shusterman & Kastak, 1993; Sidman, 1986, 1992; Smeets & Striefel, 1976; Stone, Miguel, & Gould, 2006; Stromer & McKay, 1996; Wynn & Smith, 2003; Zentall, Galizio, & Critchfield, 2002). See Miguel and Petursdottir for a comprehensive review of that literature.

In some cases the emergence of these derived relations found in Naming was proposed as *a*, or *the*, source or means of facilitating these emergent categorizations (Barnes-Holmes et al., 2001; Horne & Lowe, 1996; Miguel & Petursdottir, 2009; Miguel et al., 2008). However, others have reported emergent relations in nonhuman species (Shusterman & Kastak, 1993). Still other research has used the stimulus equivalence match-to-sample procedures to simulate emergent topography-based verbal behavior (Perez-Gonzalez, 2008). Also a growing number of programs have followed Horne and Lowe's advice to study verbal behavior directly, including emergent verbal behavior itself or verbal behavior and its facilitation of emergent categorization instead of logio-mathematical relations (Greer & Keohane, 2005/2006; Greer & Ross, 2004, 2008; Horne & Lowe; Lodhi & Greer, 1989; Lowe & Beasty, 1987; Lowe et al., 2002, 2005; Miguel et al.; Sundberg, 1998). However, Naming itself is an emergent behavior, and how it emerges is also a subject for research.

Naming as a Dependent Variable: The Study of Its Origins

The research we will describe and the related verbal developmental theory (Greer & Speckman, 2009) have focused on the identification of experiences that result in the emergence of Naming as a verbal behavior developmental phenomenon. As we described earlier, the onset of Naming appears to be related to the explosion in vocabulary that occurs at about the age of 3 years, as identified by Hart and Risley's (1995) longitudinal study (pp. 141–173). Hart and Risley reported that there were few incidences of direct reinforcement for this explosion in vocabulary. The onset of the Naming capability provides one plausible, and environmentally traceable, account for this explosion in language acquisition during what appears, at first glance, to be the absence of immediate reinforcement. (We will cite research evidence on the possible actual sources of reinforcement below.) Thus, providing experimental analyses of the environmental sources of Naming constitutes an important step in our understanding of verbal development. This quest has served as the objective of the research we describe on Naming. Are there environmental experiences that give rise to Naming, including the source of reinforcement? This research attempts to locate immediate and historically remote experiential variables associated with this verbal developmental stage, a behavioral developmental stage that meets the criterion of what Rosales-Ruiz and Baer (1996, 1997) called a *behavioral developmental cusp*. A behavioral developmental cusp is the acquisition of a behavior, such as walking, that significantly advances the organism's probability of coming into contact with consequences that allow new learning to occur. (We will elaborate on developmental cusps and capabilities below.)

When children cannot acquire both listener and speaker responses by observation of others tacting a stimulus, they lack Naming as a behavioral developmental cusp. Thus, regardless of how many name learning experiences they encounter, they cannot profit from those occasions. When children develop Naming, they can come into contact with those experiences and, in addition, they have a new way to learn language functions, a way of learning that they did not have before. We identify this as a special type of behavioral developmental cusp that we will describe below.

To study how children come to Name requires treating Naming as a dependent variable, a focus proposed by Horne and Lowe (1996). They suggested the developmental importance of Naming, but their research and that of others dealt mostly with the role of Naming in the emergence of equivalent or derived relations. The work we discuss has concentrated on the induction, or the bringing about, of Naming in children who are missing all or part of the speaker and listener components of Naming (see Table 1 for an overview of that literature). We characterize Naming as a higher order verbal operant that is one of several verbal behavioral developmental stages that have been identified experimentally in several studies (Fiorile & Greer, 2007; Gilic, 2005; Greer & Keohane, 2005/2006; Greer & Speckman, 2008; Greer, Stolfi, et al., 2005; Greer et al., 2007; Greer, Yuan, & Gautreaux, 2005; Speckman-Collins, Park, & Greer, 2007).

Table 1
An Overview of the Literature on the Identification of the Sources of Naming

Reference	Journal	Experimental analysis or conceptual paper	Brief abstract	Findings
Greer, Stolfi, Chavez-Brown, and Rivera-Valdes (2005)	*The Analysis of Verbal Behavior*	Experimental analysis; time-lagged multiple-probe design controlling for maturation and instructional history	This study tested the effects of MEI on the transformation of stimulus function across listener and speaker responses. After mastery of matching two-dimensional stimuli while hearing the tacts for the stimuli, 3 participants were probed for the emergence of a Naming repertoire. None of the participants acquired Naming as a function of matching and hearing the tact instruction. MEI was then implemented with training sets. After MEI, participants were again probed on the original set of stimuli and a novel set of stimuli to test for the emergence of Naming.	Results showed that after MEI for training sets was implemented and mastered, all three participants acquired a full Naming for the original stimuli and a novel set of stimuli.
Gilic (2005)	Dissertation	Experimental analysis; used two time-lagged multiple-probe designs controlling for maturation and history	Two experiments were conducted to test for the acquisition of a Naming repertoire as a function of MEI for typically developing 2-year-olds. Experiment 1 tested the possible sequence for teaching children a full Naming repertoire. Experiment 2 tested the effects of MEI on the acquisition of a Naming repertoire.	The MEI intervention resulted in Naming in typically developing 2-year-olds.
Fiorile and Greer (2007)	*The Analysis of Verbal Behavior*	Experimental analysis; two experiments using time-lagged multiple-probe designs to control for maturation and history	Four participants with autism were identified as not having a full Naming repertoire. Tact training alone did not result in the acquisition of a Naming repertoire. MEI was implemented across speaker and listener repertoires with one to three training sets.	Prior to the intervention, tact instruction alone did not result in the emergence of Naming. Following MEI, tact instruction alone resulted in the emergence of Naming.

Table 1, *cont.*

Reference	Journal	Experimental analysis or conceptual paper	Brief abstract	Findings
Greer and Keohane (2005/2006)	*Behavioral Development Bulletin* and *Journal of Speech-Language Pathology: Applied Behavior Analysis*	Conceptual paper and review of the literature	A program of research guided by verbal behavior (Skinner, 1957) and contemporary research on emergent behavior suggested preverbal foundational and verbal developmental cusps and cusps that are also verbal capabilities. The authors reviewed experiments that identified missing preverbal cusps and then induced them as a function of environmental interventions. The authors proposed that the sequence of experiments point to environmental sources for verbal development and how this work may contribute to a verbal developmental theory with implications for the role of cultural influences on language development in the evolution of language.	
Greer, Stolfi, and Pistoljevic (2007)	*European Journal of Behavior Analysis*	Experimental analysis; a combined experimental and control group design with a nested multiple-probe single-case design compared single-exemplar instruction with MEI and controlled for maturation and history	Control group of 4- and 5-year-olds received the same instruction as MEI children; the separate topographies were taught in separate massed instructional trials. The experimental group that received a multiple-probe design received the same numbers of instructional trials as the control group.	Naming emerged for the MEI group and did not for the control group. Subsequently the control group received MEI in a multiple-probe design and Naming emerged. Results suggest that the rotation of topographies was necessary for the emergence of Naming lending support to the notion that Naming is a higher order operant. Stimulus control involved abstractions.

Table 1, *cont.*

Reference	Journal	Experimental analysis or conceptual paper	Brief abstract	Findings
Greer and O'Sullivan (2007)	Unpublished paper	Experimental analysis	Randomly selected first-graders ($N = 56$) were probed for Naming with two-dimensional stimuli (Greek letters) at the beginning of the school year, at midyear, and at the end of the year.	Naming emerged slowly over the year for many but not all participants. Differences between English language learners and economically disadvantaged and minority students compared to upper middle-class students increased over the year, suggesting that these populations were most likely not to have Naming for two-dimensional stimuli (print). The degree of Naming correlated with achievement test scores, suggesting a relation between the emergence of Naming and academic achievement.
Lowenkron (1984, 1988, 1989, 1991)	*Journal of the Experimental Analysis of Behavior*	Experimental demonstration	A series of studies was conducted to test for the potential conditions of stimulus control for generalized relational match to sample. Participants were taught hand signs to a corresponding shape. Retraining and rehearsal procedures were also implemented. Probes were conducted on the emergence of a generalized matching repertoire.	Findings were similar in the series of studies. Results showed that generalized matching seems to be related to the structure of stimulus control. Generalized matching emerged following retraining and rehearsal procedures.

Table 1, *cont.*

Reference	Journal	Experimental analysis or conceptual paper	Brief abstract	Findings
Barnes-Holmes, Barnes-Holmes, and Smeets (2001)	*The Psychological Record*	Experimental analysis; multiple baseline to control for maturation and history	Four experiments were conducted with 16 participants to test the effects of exemplar training on the acquisition of transformation of function in relation to symmetry. Participants were exposed to name training in some form, then trained in action-object conditional discrimination. Participants were tested for derived object–action symmetry. A multiple baseline design was used to introduce exemplar training for participants who failed symmetry testing.	Results across the four experiments showed that 13 of 16 participants were not able to derive object–action symmetry prior to exposure to exemplar training. After exemplar training, participants passed symmetry tests.
Helou-Care (2008)	Dissertation	Experimental analysis; time-lagged multiple-probe designs were used to control for maturation and history	In the first experiment, 4 middle-school students, with demographic characteristics like the economic disadvantaged children in Hart and Risley (1995), were found to be missing Naming. In the second experiment, 4 middle-school students with the same demographic characteristics, who lacked Naming but could respond fluently to text at 160 to 200 words per minute accurately, participated. A story was written involving contrived words and contrived stimuli (nouns). Prior to the intervention the participants received Naming experiences with the contrived stimuli and then read the story. After reading the story they could not respond accurately to comprehension questions. The participants then received MEI training sets for Naming.	In Experiment 1 Naming emerged as a function of MEI training sets. In the second experiment, following MEI Naming emerged. After the emergence of Naming the participants' comprehension increased significantly.

Table 1, *cont.*

Reference	Journal	Experimental analysis or conceptual paper	Brief abstract	Findings
Longano (2008)	Dissertation	Experimental analyses	Three experiments were conducted. In the first experiment, 4 first-graders with autism spectrum diagnoses were found to lack Naming. In the intervention the participants were required to emit echoics for the experimenter's tacts of contrived stimuli using contrived words in listener responses. In the second experiment, the participant for whom Naming did not emerge in the first experiment received stimulus–stimulus pairing involving visual and auditory speech stimuli until selection of the stimuli that were not initially preferred became preferred. In the third experiment, 3 participants without Naming received the stimulus–stimulus pairing intervention used in the second experiment.	In the first experiment, following one to three echoic interventions, Naming responses increased significantly for 3 of the 4 participants. In the second experiment, Naming emerged for the single participant for whom Naming did not emerge in the first experiment, as a function of the stimulus–stimulus pairing intervention. In the third experiment, Naming emerged for the 3participants as a function of the stimulus–stimulus pairings.
Pistoljevic (2008)	Dissertation	Experimental analyses; Experiment 1 used a combined experimental control method and multiple-probe designs as did Greer, Stolfi, and Pistoljevic (2007). Experiment 2 used a multiple-probe design that controlled for maturation and history.	In the first experiment, a control group of preschool children received the same instruction as the experimental group who received MEI. The control group was taught the Naming topographies in separate massed instructional trials. The experimental group who received a multiple-probe design received the same numbers of instructional trials as the control group but the topographies were rotated in MEI. These procedures were a replication of the Greer, Stolfi, and Pistoljevic experiment. In the second experiment, 4 preschoolers without Naming received intensive tact instruction for five sets of five stimuli. Preintervention probes showed the participants emitted few pure tacts in noninstructional settings.	The first experiment replicated the findings of Greer, Stolfi, and Pistoljevic, in which Naming emerged from MEI but did not emerge from the same amount of instruction in which the topographies were taught separately. In the second experiment, the intensive tact intervention resulted in the emission of significant numbers of pure tacts in noninstructional settings and the emergence of Naming.

Table 1, *cont.*

Reference	Journal	Experimental analysis or conceptual paper	Brief abstract	Findings
Reilly-Lawson (2008)	Dissertation	Experimental analyses; time-lagged multiple probe designs were used that controlled for maturation and instructional history	Participants in both experiments were fourth and fifth graders with autism spectrum disorders. In the first experiment, children with Naming but who lacked phonemic responding did not demonstrate emergent English to French relations prior to training in phonemic responding. In the second experiment, participants with Naming did not demonstrate say and write correspondence prior to mastering phonemic textual responding.	In the first experiment emergent English to French relations emerged following phonemic mastery. In the second experiment, accurate correspondence between saying and writing emerged as a function of mastery of phonemic textual responding.

Research on Naming as a dependent variable has emphasized experimental analyses of the reinforcement history that gives rise to this important developmental cusp and capability. As mentioned above, a cusp (Rosales-Ruiz & Baer 1996) is a behavioral repertoire that allows children to come in contact with parts of the environment that they could not contact prior to the acquisition of the cusp (e.g., learning to walk or speak). Some cusps also meet the criterion of being a new learning capability, according to Greer and Speckman (2009) and Greer and Ross (2008). After this capability is acquired, a child not only comes into contact with parts of the environment that he or she could not contact before, but he or she also acquires the ability to learn from different forms of contact with the contingencies of reinforcement and punishment. That is, once a child can learn from observing others receive instruction, he or she not only observes the responses and consequences received by others but learns what those he or she has observed learn. There appears to be a difference between the control of the observing response, which is a contact, and learning from new operants from that contact. One might imitate, for example, an incorrect response as a kind of imitation but not respond to the incorrectness of the response. Naming seems to be a special type of cusp, one that also results in a new learning capability made possible by particular instructional histories. In the behavior-analytic study of development, cusps are seen as the result of certain prior experiences or histories of reinforcement. The focus is on the role of experience and prerequisite behaviors, in contrast to the focus of other psychological studies on the study of relations of developmental stages to age and psychological constructs (see Crystal, 2006, for a thorough review of that literature). Moreover, in verbal behavior developmental research, the effects of these histories are studied using the experimental method.

EXPERIMENTAL ANALYSES OF INSTRUCTIONAL HISTORIES

Much of the research on Naming has focused on the role of Naming on certain

types of emergent behavior, but Horne and Lowe (1996) outlined a broader function. Their theory proposed that the acquisition of Naming allowed children to learn both speaker and listener repertoires incidentally, although less attention has been paid to this aspect of their theory (Horne and Lowe, personal communication, November 26, 2005). In their paper they proposed a program of developmental research on Naming as a dependent variable: the origin of this developmental phenomenon. They stated,

> To study Naming directly entails … experimental investigation from birth, of how the young child learns the behavioral relations involved in Naming. This approach would certainly be more parsimonious; it is also in the best tradition of behavior analysis. Such a study would enable researchers to come to terms with the full complexity of the phenomenon, both in terms of the conditions that give rise to it and the interactions between the multisensory stimulation and the multimodal responding that it entails, including emotional behavior and the effects of classical conditioning. Such complexity cannot be encompassed by the logico-mathematical abstractions of equivalence. (p. 238)

Although longitudinal studies of typically developing children will be useful, it is experimental analyses of the historical experiential conditions that give rise to Naming per se that are critical. We suggest that the series of experiments, some of which are described in this paper and summarized in Greer and Speckman (2009), Greer and Ross (2008) and Greer and Keohane (2005/2006) have provided a step toward the agenda set forth by Horne and Lowe (1996) by providing experimental analyses of instructional histories that give rise to Naming and the role of Naming in subsequent development of more sophisticated verbal behavior.

Experimental approaches to verbal development, and in this case Naming, require locating (a) typically developing children who have not yet achieved Naming or (b) children with language delays who lack Naming. After this is done, delayed multiple-probe designs, experimental and control group designs, or combined experimental control group and multiple-probe designs are used to control for maturation and instructional histories. In experiments with children with language delays, researchers began to identify certain verbal developmental stages (verbal developmental cusps that are described in detail below), of which Naming may be regarded as one type (Greer & Ross, 2008; Rosales-Ruiz & Baer, 1996, 1997). That is, when the investigations found that children could not progress verbally, in listener or speaker repertoires, the investigations sought procedures to overcome the developmental obstacle that thwarted learning. The obstacles appeared to be missing verbal developmental cusps. We believe that Naming is just such a cusp, but it is a special type of cusp that we identify as a *verbal developmental capability*.

Differences and Similarities in Verbal Developmental Cusps and Capabilities

Naming appears to be a critical and a special type of verbal developmental cusp, one of the few that appears to result in the capability to learn in new ways. When it is not present, children with native language delays or children with weak language experiences are at tremendous risk, a risk for their own prognosis and a risk for the culture. In our verbal behavior theory (Greer, 2008; Greer & Ross, 2008; Greer & Speckman, 2009), we distinguish between cusps that are new learning capabilities and those that are not. When one acquires cusps, he or she comes into contact with aspects of the environment that he or she could not before (Rosales-Ruiz & Baer, 1996); he or she learns from direct new contact with direct-acting contingencies or stimulus–stimulus pairings associated with the newly contacted features of the environment. Children can now contact the environment in ways they did not before; however, they still learn or are taught by direct reinforcement and correction or direct stimulus–stimulus pairings. However, when they acquire a cusp that is also a capability, they can learn from nondirect or incidental contact with contingencies and pairings. For example, after children acquire generalized observational learning, they can learn through observational contact with instruction received by others (Catania, 2007; Greer, Singer-Dudek, &

Gautreaux, 2006; Reilly-Lawson & Walsh, 2007). Children with Naming acquire speaker and listener functions incidentally without direct instruction or even observing others being taught. As we will describe below, they learn as a result of a particular history of instruction that results in control by different contingencies. After each of the cusps that are also capabilities (e.g., Naming, observational learning, generalized imitation) are in place, a child can learn from the environment in ways that he or she could not before. Without the cusp, children cannot contact critical features of that part of the environment that expands their verbal behavior (e.g., mands, tacts, autoclitics, intraverbals). Such cusps also include conditioned reinforcement for visual stimuli, such as pictures or print (Keohane, Greer, & Ackerman, 2006b; Keohane, Pereira-Delgado, & Greer, 2009; Tsai & Greer, 2006), and auditory stimuli (Keohane, Greer, & Ackerman, 2006a).

Children Without Naming

In our work with children with language delays, it appeared that those who could not progress verbally using the existing tactics in verbal behavior and applied behavior analysis lacked certain verbal developmental cusps. It was ''difficult, tedious'' (Rosales-Ruiz & Baer, 1996, p. 166), and often impossible to make progress beyond expanding their skills within existing repertoires. For example, if a child cannot learn from the speech of others, new objectives can only be taught using his or her existing cusps and capabilities. Thus, if the child could not contact the speech contingencies in the environment yet other children could profit, what was potentially missing was a behavioral developmental cusp. This meant that, for them, ''no or little further learning was possible in this realm'' (p. 166) of verbal behavior and in related realms; they lacked the necessary ability to contact the experience or the capability to learn from the experience. When progress was made, it was dependent on frequent use of prompts that needed to be present for each subsequent instructional objective within a given repertoire. In the case of those who lacked Naming the learning of listener responses and speaker responses for the same stimuli required separate and direct instruction. However, if we could identify how to induce the Naming cusp and capability, progress could be made without continued reliance on direct instruction.

We experimentally manipulated the children's instructional histories such that the missing verbal developmental cusps or capabilities emerged. In this effort we tried to identify special experiences or instructional histories that might lead to the emergence of Naming. Hayes et al. (2001) and Blackledge (2003) proposed that a possible source for certain higher order operants, like the Naming capability, is multiple-exemplar experiences. Incidental multiple-exemplar experiences, or in our experiments multiple-exemplar instruction (MEI), suggested a history of reinforcement for relating different stimuli, or in our case, multiple responses to stimuli. It was theorized that after an individual has experienced MEI for stimuli across multiple responses for those stimuli, new or novel stimuli may relate to multiple responses without direct instruction. This led us to isolate the role of MEI on the acquisition of Naming and other experiences that contribute to its emergence.

Identified Sources of Naming

The term *multiple-exemplar instruction* (or *multiple-exemplar training*) is used in several different ways and has a long history (Engelmann & Carnine, 1991; Fields et al., 2003; Greer & Lundquist, 1973). We point out these distinctions to clarify how we use this term. In some applications of behavior analysis, the term refers to multiple-exemplar experiences with a subset of exemplar stimuli that result in stimulus control for novel arrangements of those stimuli or abstractions. These procedures involve the rotation of different irrelevant characteristics of a stimulus conglomerate (e.g., teaching particular colors when the irrelevant properties of shape, texture, size, etc. are varied while responding to colors alone is reinforced). In some applications, instructional trials with positive exemplars are also contrasted with negative exemplars, as in the general case procedure prominent in the work of Engelmann and Carnine. For example, multiple exemplars of a color (i.e., differential rein-

forcement of accurate responses to presentations of the range of hues for a color across shapes, textures, sizes, and dimension), contrasted with nonexemplars, lead to the identification of the color when it occurs in novel objects as well as new variations of the color. The essential stimulus control of the color or other concept is acquired (Engelmann & Carnine). One common usage of this type of MEI is to teach phonetic reading. In this case, instruction consists of multiple exemplars of responding to phonemic blends for a subset of possible combinations (e.g., vowel-consonant blends, consonant-vowel blends, and assorted combinations), and this leads to accurate phonemic textual responding to novel arrangements of the phonemes in words the reader has not previously encountered (McGuiness, 2004). In such cases, teachers or experimenters seek to induce the control for blending vowel-consonant arrangements when the student encounters novel words. This type of stimulus control makes it possible for the student to respond textually to novel words (McGuiness, 2005). The child learns to respond similarly to multiple examples and novel arrangements of the stimuli.

The MEI protocol for inducing Naming. In the case of Naming, MEI is a bit different. Instead of varying the relevant and irrelevant properties of stimuli only for single responses, multiple responses are learned for single stimuli and variants. That is, an observational instance results in stimulus control for both listener and speaker responding. Initially the response may be one (e.g., a tact) that produces the stimulus for the other response (e.g., a listener response), but eventually the original stimulus evokes both responses.

First we identify several sets of stimuli the children can neither tact nor respond to as a listener, such as (a) obscure animals, gemstones, leaf types of trees (Greer, Stolfi et al., 2007); (b) contrived stimuli and contrived tacts (Fiorile & Greer, 2007; Gilic, 2005; Greer, Stolfi, et al., 2005; Helou-Care, 2008; Nirgudkar, 2005; Pistoljevic, 2008); (c) Korean language symbols (Lee-Park, 2005); and (d) mixed contrived and obscure stimuli (Greer, Stolfi, et al.). After it has been established that the students are not familiar with the stimuli (e.g., they cannot tact or respond to the stimuli as listener or speaker), the children are taught to match to sample for visual stimuli while the experimenter says the tact for the stimuli, thus simulating the natural conditions described by Horne and Lowe (1996). We then conduct no-feedback probes to determine if children can respond as listeners by pointing to the positive comparison in an array of two or three stimuli. We also assess whether the child can tact the stimuli when shown the stimulus or asked, ''What is this?'' When we establish that the child is missing all or part of the listener response, or has all of the listener responses but is missing the speaker responses, we introduce him or her to a separate training set of stimuli and use MEI across listener and speaker responding to teach the listener and speaker responses for these training stimuli.

The MEI protocol involves teaching one or two training subsets of five stimuli by rotating instructional trials (that meet the criterion for learn units) across (a) matching a visual stimulus while hearing it spoken, thus ensuring joint attention and a Naming observational experience are present, (b) responding with intraverbal and pure tacts to the stimulus that was matched, and (c) responding with listener or selection responses to the stimuli. In this instruction a visual and auditory match-to-sample instructional trial or learn unit (learn units include reinforcement for correct responses and corrections for incorrect responses) is followed by an opportunity to point to a different stimulus, followed by a learn unit for a tact for still another stimulus. Presentations of learn units are done such that the child cannot simply echo the response for the prior instructional trial; that is, the same stimuli are not presented for the next response in the rotation across listener and speaker responses.

The *learn unit* is an experimentally tested type of instructional trial that has been shown to be an efficient instructional procedure (Albers & Greer, 1991; Bahadourian, Tam, Greer, & Rousseau, 2006; Emurian, 2004; Emurian, Hu, Wang, & Durham, 2000; Greer & Hogin-McDonough, 1999; Hogin, 1996; Selinske, Greer, & Lodhi, 1991). The characteristics of the learn unit were suggested in Skinner's (1968) programmed instruction frame. Learn units require that (a) the

participant is attending to the stimulus, (b) there is an opportunity to respond, (c) correct responses are reinforced with consequences that have been shown to reinforce learning, (d) the participant must emit an accurate response following incorrect responses, and (e) the corrected responses are not reinforced.

These instructional trials or learn units continue until all of the rotated responses to all of the stimuli for the training set of stimuli are mastered (for details, see Greer & Ross, 2008; Greer, Stolfi, et al., 2005; Greer et al., 2007). Each stimulus is taught with rotated multiple exemplars of speaker and listener responses. Rotating listener and speaker responses across stimuli appears to be critical to establish Naming, because teaching the responses separately in massed trials using the same numbers of learn units did not result in Naming (Greer et al., 2007; Pistoljevic, 2008) Indeed, the multiple exemplars are exemplars of both speaker and listener responses to training sets of stimuli. However, in all of the studies, there were also multiple exemplars of the stimuli (i.e., different visual versions of the same stimulus taught across listener and speaker responding). That is, in each study different versions of a particular stimulus were rotated along with the speaker and listener responses. For example, different visual displays of a particular type of bird were provided. After the child had mastered one or more sets, we again conducted no-feedback probe trials with the initial set of stimuli that the child could not tact as a speaker or point to as a listener. No additional auditory and visual match-to-sample trials while hearing the tacts for the original stimuli occurred since the original probe conditions. In many cases several weeks passed since the children experienced hearing the words for the stimuli, except in the probe trials for which there was no feedback.

In these studies, after MEI the children emitted the untaught and unreinforced responses for the initial probe set at 80% accuracy or better. Next, in most experiments we taught the children to match an additional novel set of stimuli while the experimenter tacted the stimuli. When the children demonstrated mastery of the matching response while hearing the tacts, we probed them for the listener and speaker responses, and the untaught responses were emitted at 80% accuracy or better for the novel set. At this stage we concluded that the children had Naming as a verbal developmental cusp and a new learning capability. In summary, when we applied MEI across listener and speaker responses with training sets, children who did not have Naming acquired it (Fiorile & Greer, 2007; Gilic, 2005; Greer & O'Sullivan, 2007; Greer et al., 2007; Helou-Care, 2008; Pistoljevic, 2008).

After children who were missing Naming (and who had particular prerequisite capabilities) acquired Naming from MEI, they had the potential to learn listener and speaker behavior incidentally. That is, they could learn speaker and listener responses to visual stimuli in a way that they could not before the emergence of Naming.

Horne and Lowe (1996) suggested that Naming occurs at about 2 years of age, although in one of our studies the evidence suggests that 3 years might be more typical (Gilic, 2005). Gilic found that 10 of 10 3-year-old children had Naming, and 8 of 10 2-year-olds lacked Naming. Regardless of the age, simply identifying the typical age when children have Naming does not suggest how it comes about. Our studies suggested how it might come about from experiences. For example, the toddlers in Gilic's study could learn new speaker and listener word–object relations as a function of their MEI history.

The evidence in the studies cited herein suggests that children who lacked Naming acquire it as a function of a particular type of MEI, with one or more exemplar stimulus sets or other related experiences that we describe below. After acquiring Naming, the children emitted both speaker and listener responses after hearing someone tact novel stimuli while the children also attended to the stimuli. In another experiment, children with no speaker repertories acquired the listener half of Naming by MEI with matching and pointing alone (Feliciano, 2006). More recently, we have identified other interventions that have resulted in Naming.

Pistoljevic (2008) found that Naming emerged as a function of intensive tact training. Intensive tact training is a procedure that previously was found to be effective in significantly increasing children's spontaneous tacts in noninstructional settings (Greer

& Du, 2010; Pistoljevic & Greer, 2006; Schauffler & Greer, 2006). As Skinner (1957) pointed out, the tact is a key verbal operant. (See Crystal, 2006, for the importance of the tact as a critical developmental stage and Commons & Miller's, 2008, argument that the tact distinguishes most nonhuman animals from human animals; but see also Premack, 2004, and Premack & Premack, 2003, for a different interpretation.) Although the effect of the intensive tact procedure on tacts in noninstructional settings has been replicated in several studies, the emergence of Naming was a surprising finding. Why did the intensive tact procedure result in Naming?

The emergence of Naming from intensive tact instruction appears to be a function of the implicit rotation of speaker and listener opportunities found in the intensive tact instruction, but further analysis is needed. In intensive tact instruction, children are taught tacts for sets of stimuli (100 learn units daily in addition to baseline levels of curricular instruction); this has led to substantial increases in children's emission of spontaneous or student-initiated tacts in noninstructional settings. In Pistoljevic's (2008) studies, this procedure also, and surprisingly, led to the emergence of Naming. This procedure is similar to the kinds of experiences typically developing children have as they enter the language explosion stage, in which they emit tacts and receive adult attention or emit questions such as, ''What's that?'' We think that the process of learning tacts involves the children echoing the tacts initially, because they must learn to say or echo the word in the process of learning the tact, until the child emits the tact without echoic instruction. This process appears to join the listener and speaker repertoires and may be more similar to what occurs with typically developing children as they learn the names for things.

Still other procedures have been found to induce Naming. Longano (2008) found that Naming emerged as a function of two different but related procedures: (a) having participants echo current responses to listener instruction and (b) using stimulus–stimulus pairing for second-order classical conditioning. In her first experiment, 3 children who did not acquire Naming as a function of MEI received an intervention in which they were required to echo as they were taught listener responses. They were taught to emit a visual match-to-sample response while the experimenter tacted the stimuli (placing a picture to a matching picture when nonmatching pictures were available), and they were required to echo as they pointed to the correct stimulus in an array that included the correct stimulus and incorrect stimuli. That is, as a child matched a stimulus or pointed to the stimulus, he or she was required to echo the experimenter's tacts of the stimuli. One of the 3 participants acquired Naming to 80% accuracy. One of the participants who did not acquire Naming then received stimulus–stimulus pairings for looking at computer-generated shapes and hearing recordings of the tacts for the stimuli. After identifying which of the vocal or visual stimuli reinforced observing responses with test stimuli, the reinforcing stimulus was paired with the one that did not reinforce observing responses until the nonreinforcing stimulus reinforced observing responses. The 3rd child who did not acquire Naming from MEI or the echoic training procedure did acquire Naming from the stimulus–stimulus pairing procedure. In the final experiment, 3 children who lacked Naming acquired it as a function of the stimulus–stimulus pairing procedure alone. As the children received the stimulus–stimulus pairings they began to echo, suggesting that the procedure facilitated echoics that in turn resulted in automatic reinforcement.

The latter finding is consistent with Stemmer's proposal that Naming emerged from a history of second-order classical conditioning (Stemmer, 1973, 1990, 1994, 1996). The experiments cited above have not yet been subjected to peer review, but they do suggest that Naming can emerge from procedures other than MEI. It is likely that MEI simply provides an extensive experience that incorporates the experiences found in echoic training, provided that that the echoic has acquired conditioned reinforcement. If children are missing the echoic as a conditioned reinforcer, then stimulus–stimulus pairing experiences may provide the necessary prerequisite.

We characterized Naming as the emergence of joint stimulus control across tacting

and listener responding when the simultaneous observation of the stimulus by the person tacting the stimulus and the child results in those stimuli controlling the emission of both tact and listener responses, hence the joint control of both responses from the observing incident. Of course there can be a wide range of derived relations among stimuli or a frame that accrues simultaneously as in ''conditioned seeing, smelling, touching'' of a rose as well as respondent effects, as described above (Greer & Speckman, 2009; Healy, Barnes-Holmes, & Smeets, 2000).

The participants in several of the studies on MEI, stimulus–stimulus pairing, and echoic training were children with language delays; this may raise some problems from a scientific perspective, as we will describe below. However, the benefits of the procedure with language-delayed children are that it allowed the researchers to isolate and manipulate instructional histories and control for prerequisites experimentally (Fiorile & Greer, 2007; Gilic, 2005; Greer, Stolfi, et al., 2005; Greer, Wiegand, & Kracher, 2006; Greer, Yuan, & Gautreaux, 2005; Speckman-Collins, Park, & Greer, 2007).

Is This How Typically Developing Children Learn to Name?

A potential flaw in studying children with language deficits with regard to identifying a broadly applicable developmental trajectory is that the special interventions that lead to the emergence of verbal developmental cusps for these children might somehow be different than the incidental acquisition of these capabilities by typically developing children. Nevertheless, we argue that a great deal can be learned about typical development by studying children with language delays. Moreover, the experiments with typically developing children who also lack Naming have resulted in similar findings. The typically developing 2-year-old children in the Gilic (2005) study who lacked Naming were tested to determine whether their development could be accelerated through MEI. Naming was developmentally accelerated with these typically developing children using MEI just as it had been induced for the children with language delays. The advancement of the acquisition of Naming for typically developing children may have important educational values; it may, for instance, accelerate these children's acquisition of new vocabulary. Moreover, we have tested other typically developing children for Naming (Greer & O'Sullivan, 2007) and induced it with MEI (Greer et al., 2007). Figures 1 to 4 show the responses lacking before Naming was present and the progression to the onset of Naming.

By studying both children with language delays and typically developing children for whom cusps have not yet emerged, we tested for the role of experience in the induction of verbal capabilities, in this case the particular capability of Naming. This does not mean that such experiences are necessarily the only source for all or most children, but it does suggest that MEI may be sufficient to generate Naming (Feliciano, 2006; Fiorile & Greer, 2007; Gilic, 2005; Greer, Stolfi, et al., 2005; Greer et al., 2007; Speckman et al., 2005). These findings do not eliminate the possibility that other experiences may induce Naming, but they do provide evidence that experiences do, and this finding casts considerable doubt on certain aspects of the innate propositions (Pinker, 1999; Premack & Premack, 2003).

HOW NAMING CONTRIBUTES TO MORE COMPLEX VERBAL BEHAVIOR

When Naming Joins Textual Control

The Naming capability and the experience of a particular observational incidence for a ''name'' (hearing the word for a stimulus while the observer jointly attends to the auditory stimulus produced by a tact) provide the foundation to more advanced capabilities. Horne and Lowe (1996) gave some examples of how Naming contributes to other verbal operants. We suggest some additional possibilities. For example, after a child acquires textual control of phonemic sounds for letters of the alphabet (an abstraction that can be taught by MEI), the stage is set for the child to say the phonemic sounds of the letters comprising, for example, the word *elephant* (Figure 5). When the child encounters *elephant* as a novel printed word and he or she

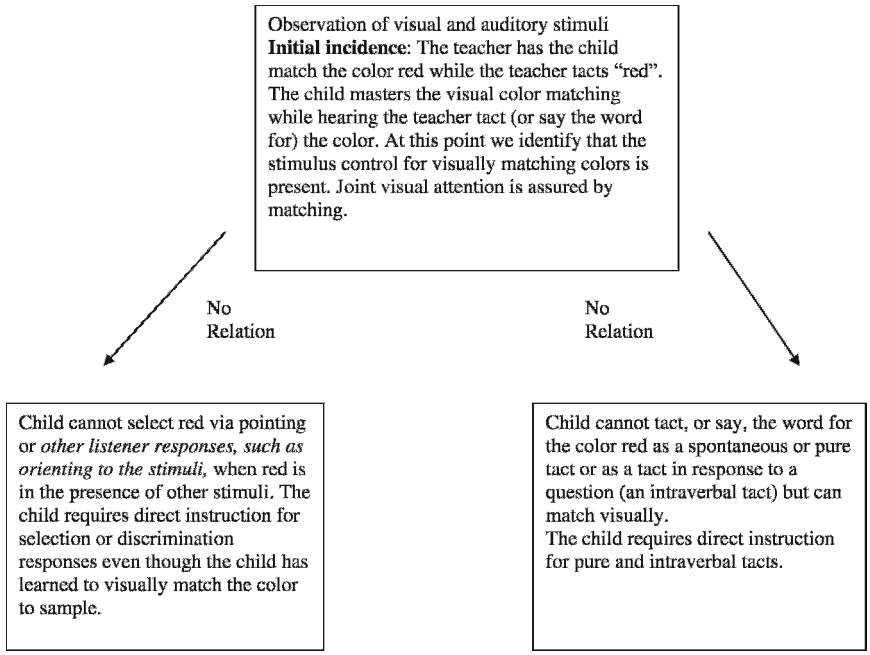

Figure 1. A child who lacks the either the listener or speaker repertoires of Naming. Following joint attention of the child and a speaker to stimuli as a speaker says the words for the stimuli, the child cannot emit either listener or speaker responses to the stimuli without direct training. The child has demonstrated that he or she is attending to and can visually or observationally match the stimuli but does not learn the speaker or listener response.

can textually respond to the phonemic sounds of the word, he or she also hears the word as a listener. When he or she hears the word as listener, the prior Naming experience with elephants results in conditioned seeing (Skinner, 1957) of the elephant and also the related emotional respondents that occurred in the initial Naming experience. This allows the child to comprehend what he or she has read. If children have phonemic textual control but they lack Naming, comprehension may be poor. Helou-Care (2008) found that children with accurate phonemic responding from 150 to 200 words per minute (but who lacked Naming) had poor comprehension. However, after she induced Naming using MEI, their comprehension improved significantly.

Moreover, if the child has acquired transformation of stimulus control across saying and writing, he or she can also spell the word (McGuiness, 2004). Greer, Yuan, and Gautreaux (2005) identified children who were missing the transformation of stimulus control across spelling words vocally and writing words, or vice versa. This effect has been replicated by Eby, Greer, Tullo, Baker, and Pauly (2010). Before the children had transformation of stimulus function across saying and writing, when they learned to spell a word in either a written or the spoken topography they could not emit the untaught topographies. After they received MEI to master training sets of saying and writing, they could be taught one response form of spelling and emit the untaught form at 80% to 100% accuracy. The dictated word as stimulus was transformed from control of a single response (saying or writing) into control for two responses for the dictated word (saying and writing) Thus, in our example of the emergent relations for the joining of Naming to text (Figure 5), he or she can not only comprehend but also has transformation of stimulus function across saying and writing, and is able to spell the word.

Thus, after textual stimulus control for phonemic textual responding joins the Naming capability from a particular observational

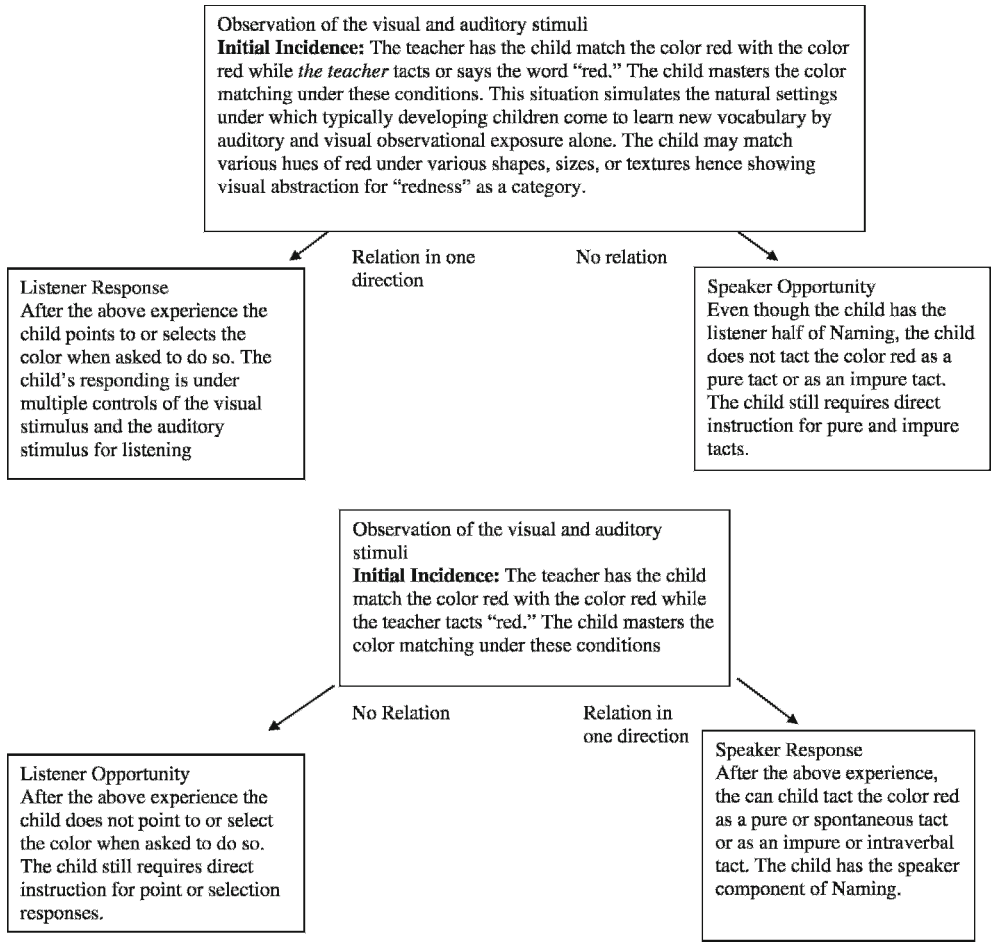

Figure 2. A child with the listener half of Naming (top) and a child with the speaker half of Naming (bottom). The child has one of the components of Naming but is missing the other.

experience, the word said as a textual response (and heard as speaker-as-own-listener) is then comprehended (Helou-Care, 2008). Figure 5 illustrates the joining of Naming to textual stimulus in reader and writer functions along with possible resulting emotional responses. If they also have transformation of saying and writing they can also spell the word.

This account offers a plausible behavioral developmental source for the fact that academically successful children acquire 86,000 vocabulary words in elementary school (McGuiness, 2004), a number that is impossible to acquire by direct reinforcement and training. Moreover, if they have transformation of stimulus control across saying and writing, they can spell many words without direct instruction (e.g., after they learn to spell the word by saying the letters, they can write the word and vice versa). It seems plausible that Naming, and the experiences that make Naming possible, account for much of vocabulary attained by children before and after they have textual stimulus control. This subsequently affects reading and writing. The source is a learned observational capability (Naming) made possible by prerequisite verbal capabilities and prerequisite nonverbal cusps (Greer & Keohane, 2005/2006; Greer & Ross, 2008).

Prerequisite Stimulus Control for Naming

Naming begins with observing responses. When the stimulus has conditioned rein-

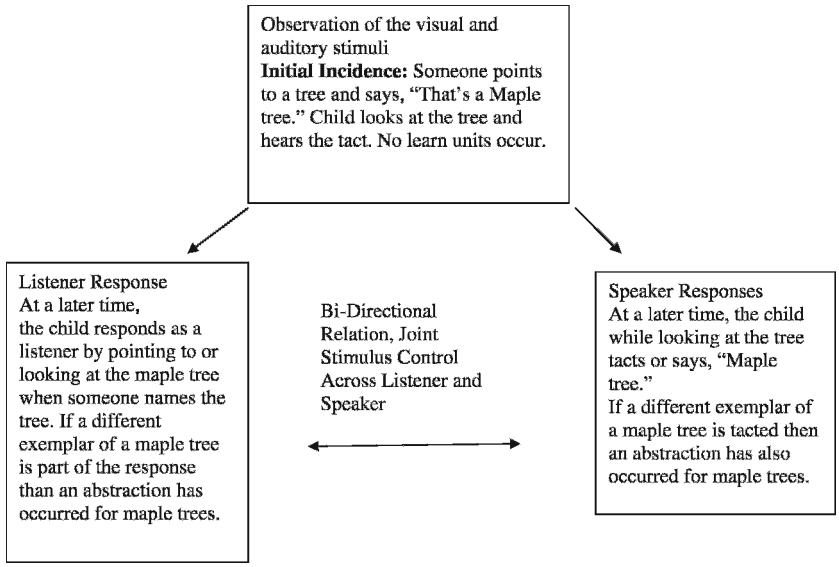

Figure 3. A child with full Naming. After the child can match the stimuli while hearing the tact for it, he or she can emit the speaker and listener components without direct instruction on the speaker or listener responses. From the observations of seeing the stimulus and hearing the tact, full Naming accrues.

forcement for observing responses (i.e., the child attends to both a visual stimulus and the spoken word), discrimination proceeds more quickly (Dinsmoor, 1983; Pereira-Delgado, Greer, & Speckman, 2008; Tsai & Greer, 2006). One observes or contacts the nonspoken stimulus via one, more, or all senses. Humans who are sensorially intact can observe by looking, smelling, tasting, hearing, and touching, or any combination or all of these senses. In the name observation, hearing what another says relative to the nonvocal or nonverbal stimulus occurs simultaneously. In the listener component of

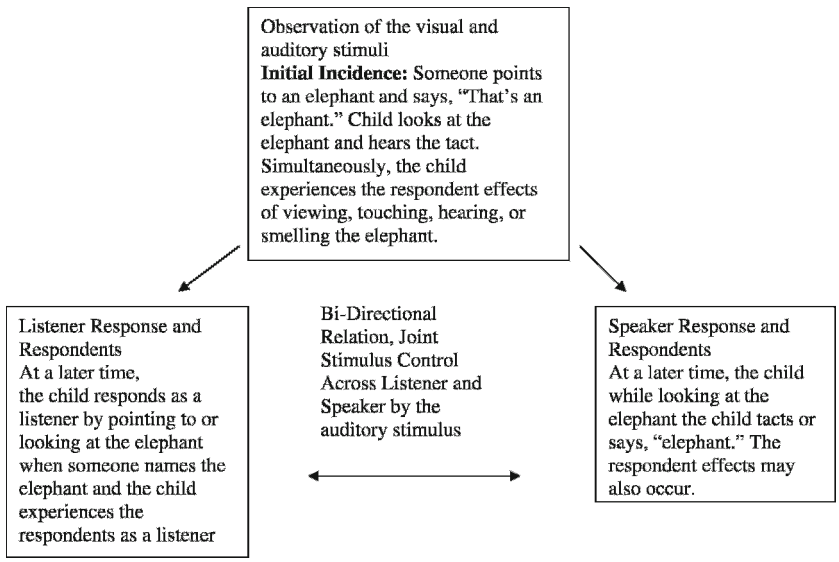

Figure 4. How emotional respondents may accrue from the observational experience for a child with full Naming.

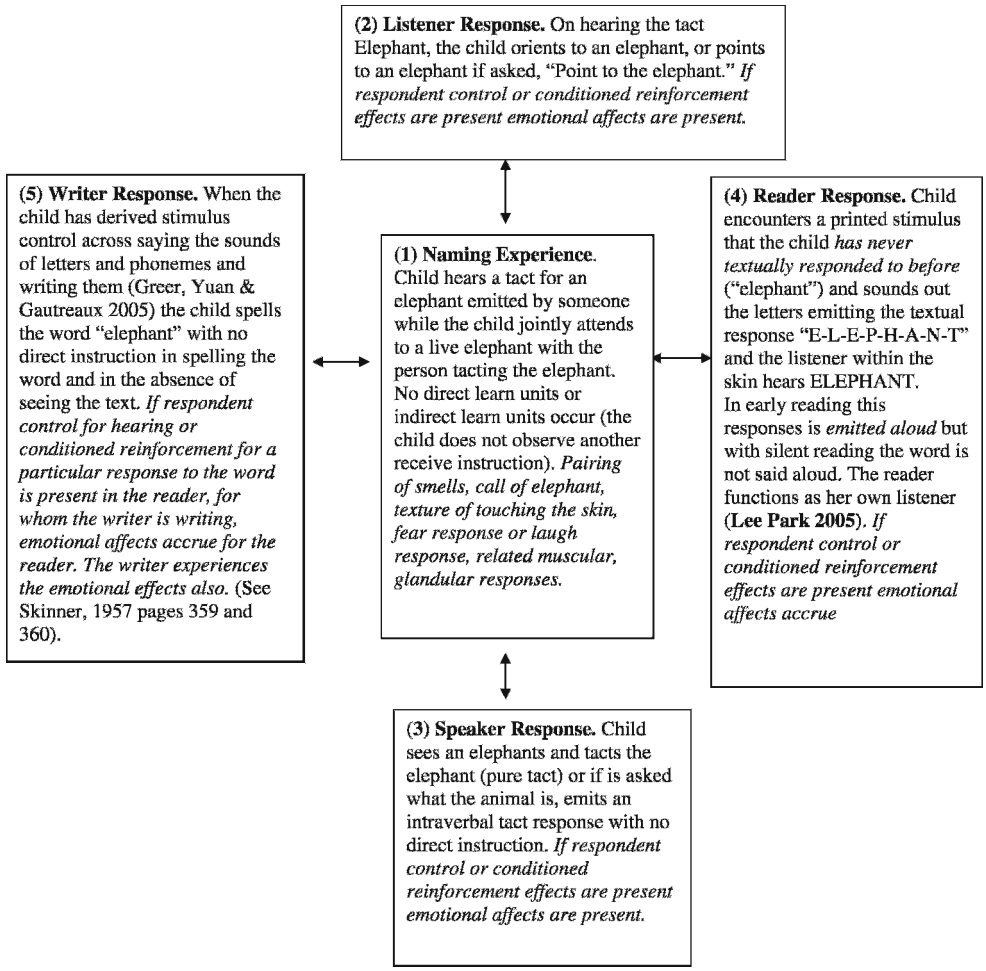

Figure 5. Joining of Naming to print control. Provided the child has the phonemic stimulus control and the transformation of stimulus control across saying and writing, reading comprehension and spelling responses emerge without direct instruction, and the respondent relations may also accrue.

Naming, one orients to, or points to, the object tacted by another, and in the speaker component, one produces or emits the tact either as a pure tact or as an intraverbal tact in the presence of the stimulus. Horne and Lowe (1996) suggested that the echoic also plays a role as a reinforcer, a point that Longano (2008) suggests to be possible. Of course, to tact initially one must emit the echoic, because without the echoic repertoire the tact cannot be acquired (Ross & Greer, 2003; Tsiouri & Greer, 2003; Williams & Greer, 1993). Clearly, the echoic is necessary for the eventual emission of the tact, and the echoic is not without its complexities. For example, one may hear someone tact a stimulus in an unfamiliar language and be incapable of echoing; hence, he or she cannot go from the echoic to the tact or emit a listener response without special instruction. The tact may occur in the absence of the stimulus too, as in the case of conditioned seeing (Skinner, 1957).

The types of vocal speech sound in one's echoic repertoire (e.g., consonant-vowel sounds) control Naming (see Horne & Lowe, 1996, for a review of the literature on this process). Probably at some point, one could point to a stimulus associated with an experience in which a native speaker tacted an object in a language that is unfamiliar, probably as a result of experiences with one's

primary language, yet not be able to emit the echoic that would be required to tact the stimulus. Matching the auditory spoken stimuli with the stimulus said or tacted as a listener or selection response may be easier than emitting the spoken tact (Chavez-Brown & Greer, 2009). However, the listener response involved in the listener half of Naming in the foreign tongue also requires matching what is heard to what is said. The selection response may be easier than matching one's own speech sound to the heard sample. In the latter case, one must match what one says with what is heard (speaker-as-own-listener). At this stage, one must determine the correspondence between what one says and what one has heard another say. One must observe the correspondence between one's own response and that of the model. The process of matching, as a production response, may be more difficult, as in the case when one matches a production response yet emits the response with a different accent. In the latter case, the speaker may be convinced that he or she has matched the sound with point-to-point correspondence, but that may in fact not be the case (an American speaker from the South may echo, saying ''pin,'' what the speaker with a different accent actually said, ''pen'').

JOINING OBSERVATION AND PRODUCTION RESPONSES

Something similar to responding as an observer versus responding as a producer happens when one matches an action another performs with one's own action. When one can match actions that are novel, this is referred to as *generalized imitation*. In this case, one also observes his or her own actions relative to the action being imitated. However, seeing and producing involve different observing and producing responses than hearing and saying. Similar relations are involved in making music. In this case one produces music sounds that correspond to the music sounds one hears (see Figures 6, 7, and 8 for the observing and producing responses and the joining of them involved in the visual arts, the musical arts, and dance). Thus, correspondence between observing and producing can occur with (a) actions as in, say, learning to emit dance steps by observing another (generalized imitation) (Figure 8); (b) seeing an object and drawing, carving, or sculpting a duplication (emulation) (Figure 6); (c) hearing a musical phrase and reproducing it (emulation; Figure 7); and (d) hearing a spoken word and reproducing the word (parroting if the child is not verbal, both of which are examples of emulation). The functions or reinforcement for each of these differ, as we describe below. In music, dance, and art the reinforcement is automatic, whereas in verbal behavior the reinforcement is derived from the mediation of the listener for the speaker and the speaker for the listener.

Joining Verbal and Other Observing and Producing Relations

Presumably, either imitation or emulation relations may occur in any of these different observing and producing categories, also perhaps as a result of multiple-exemplar experiences building on stimulus–stimulus pairing histories. Emergent visual relations (as in art) need not involve verbal stimulus control. Similarly, emergent musical responses need not, and should not, involve verbal stimulus control because the reinforcement is correspondence between what is heard (i.e., as an auditory observation) and what is produced. Note that the musical example involves something like parroting (a kind of emulation, perhaps), whereas dance involves generalized imitation. The visual arts also involve emulation (see Catania, 2007, for distinctions between imitation and emulation), and the reinforcement is correspondence between the observed product and the product produced. Emulation is the production of the end product, an outcome not necessarily based on imitation of particular movements or mimicry.

But the verbal observing (listening) and producing (speaking) relations have special functions that set verbal behavior apart, and that is the social mediating function of verbal behavior relative to nonverbal stimuli; a major point of Skinner's (1957) theory. In the verbal function, the reinforcement accrues from emitting speech or speech substitutes (e.g., sign language, smoke signals) such that a listener-observer mediates between the speaker and his or her environment. Also, the

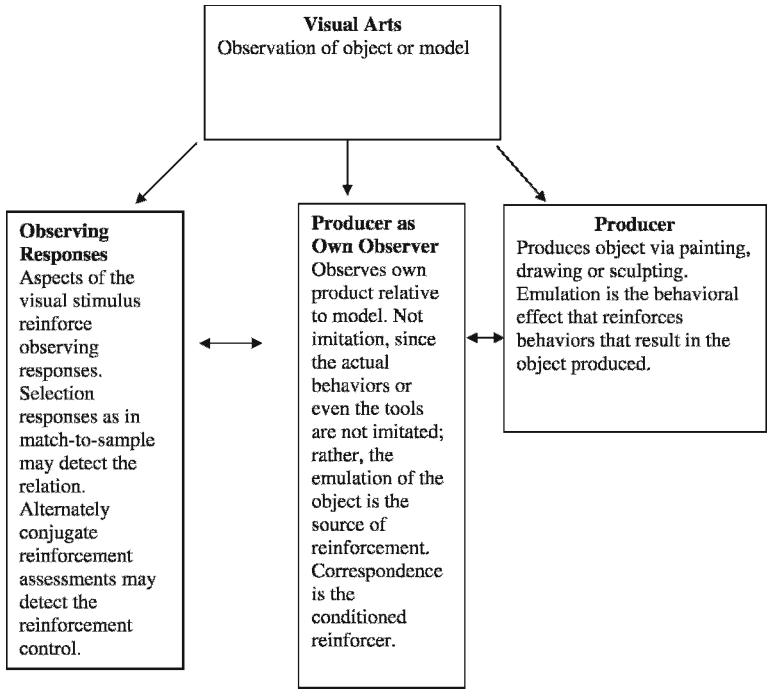

Figure 6. The separate visual observing and producing responses in the visual arts, and the joining of these in emitting behaviors that result in emulation and permanent products.

listener in verbal behavior has his or her senses extended by listening to the speaker (p. 359), that we argue is a verbal function for the listener. This sociocultural function underlies the reinforcement for the observing and producing functions peculiar to verbal behavior. Presumably, expanding one's listener and speaker vocabulary extends the options for

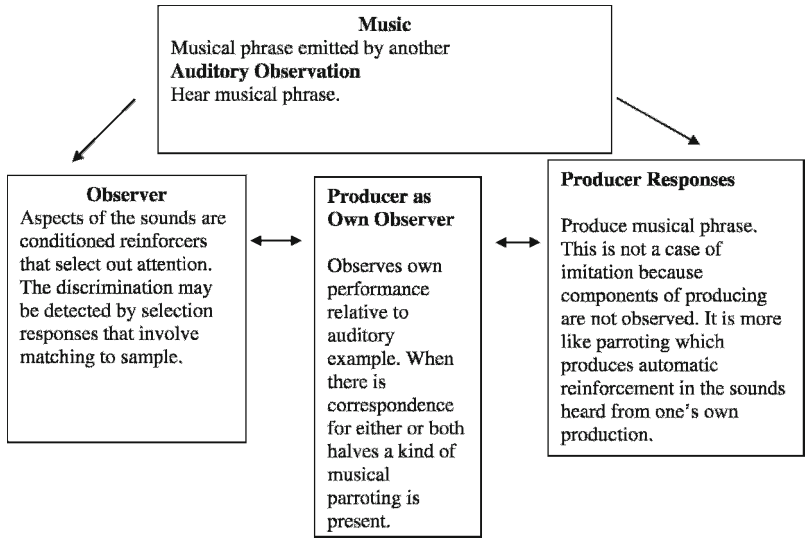

Figure 7. The separate auditory observing responses and production responses involved in music. The conditioned reinforcement for what is heard and the resulting production are automatically reinforced by the correspondence between what is produced and what is heard. Something like parroting is involved.

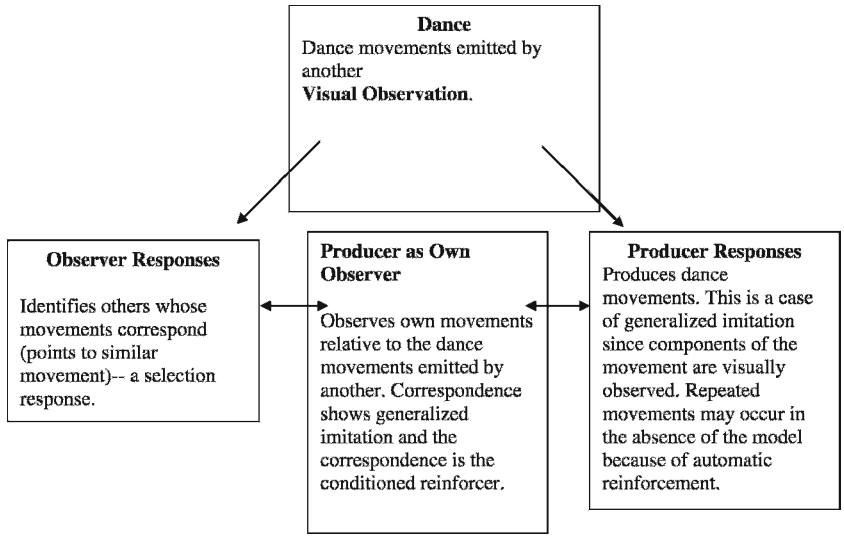

Figure 8. The separate observing and producing responses in dance, and the joining of these in dance performance. The process involves generalized imitation, in which the correspondence between seeing movements and producing correspondence is involved. The correspondence between one's performance and production of movement provides automatic reinforcement that originates from the conditioned reinforcement of this correspondence.

reinforcement. Thus, as one acquires increased verbal correspondence between what is spoken relative to other stimuli observed, one expands one's options for reinforcement associated with the various motivational conditions or establishing operations that correspond to the use of ''names.'' When social contact is reinforcing, tacts are useful. Naming exponentially expands the means for greater social reinforcement (Pistoljevic & Greer, 2006); this strengthens Skinner's characterization of verbal behavior as social behavior.

Different Senses Involved: From Overt to Covert

Any or all of the senses may be associated with Naming. Acquiring Naming of olfactory stimuli, for example, may occur at different stages than Naming of tactile or gustatory stimuli or nonspeech auditory stimuli based on one's instructional history (e.g., feeling a smooth surface and tacting ''smooth,'' tasting a sweet substance and tacting ''sweet,'' smelling a rose and tacting ''rose,'' hearing a trumpet and tacting ''trumpet''). But after the range of Naming stimuli is expanded, it may then be only a small step to acquisition of Naming for private stimuli, such as pain or various glandular, muscular, or other physiological sensations. Of course the accuracy of these private events involved is questionable, but regardless of accuracy, social acceptance of the private tact is made more acceptable to a particular verbal community based on public agreement and the extensions of the tact (Skinner, 1957). Agreement is acknowledged generally to be difficult or impossible to obtain in the case of private or covert stimuli, but it is also true that learning to acquire agreement between one's own dance movements and those of the person one attempts to model is also very difficult (again observing and producing relations). The accuracy of behavior beneath the skin is difficult to ascertain, but difficulties also are found in ascertaining one's behavior outside the skin relative to duplicating the behaviors of others (as in learning a new dance step). However, in the case in which one's observation of one's own correspondence with a model is difficult, others can observe the correspondence or lack thereof.

Naming and Formal Education

In education, when Naming must join textual stimuli (i.e., print) or other two-dimensional representations, another step

must be made. That is, when children enter the early grades they must have Naming for two-dimensional stimuli, including pictorial representations and printed stimuli that are to correspond with phonemic sounds for text. In the latter regard, typically developing children appear to have Naming for three-dimensional objects (Gilic, 2005), but first-graders are often missing Naming for two-dimensional stimuli (pictures of obscure or contrived stimuli). In a recent study of 56 first-graders, we found that all but 4 children were missing full Naming for unfamiliar two-dimensional stimuli at the beginning of the year. We also probed for Naming for two-dimensional stimuli at the middle and end of first grade (Greer & O'Sullivan, 2007). We did not intervene to induce Naming; rather, we assessed whether it emerged in the school year, probably as a result of types of MEI. At the middle and end of the year, more first-graders had it, but many did not. Those who were most likely not to have it were those who were economically disadvantaged (Hart & Risley, 1995) or those for whom English was a second language. The gap (standard deviation or variability) between those with and without Naming increased over the year, with the gap widening between the upper middle class children and those who were English language learners or economically disadvantaged. This gap was similar to and correlated with the gap that existed for these children in their performance on standardized tests at the end of the year. Perhaps a portion of the educational gap between the economic classes is associated with the lack of Naming for two-dimensional stimuli. Thus, not only do the economically disadvantaged students have a much smaller vocabulary, as Hart and Risley (1995, 1999) found (due to fewer language interactions), but they also may have a deficit in Naming for two-dimensional stimuli.

It is also possible that these children have weak or nonexistent Naming for three-dimensional stimuli, and thus their vocabulary is thwarted in terms of weak Naming for three-dimensional stimuli too, although we have not studied this. Taken together, the weak Naming for three-dimensional stimuli combined with the lack of Naming for two-dimensional stimuli spells educational disaster. To reiterate, it is impossible for children to receive enough direct instruction for textually responding to the 86,000 words they will need in elementary school (McGuiness, 2004, 2005). Moreover, reading comprehension requires the listener and speaker components of Naming, because direct instruction in all of those tacts is impossible. The principal way children can acquire the tacts and listener responses for comprehension is through a combination of Naming for three-dimensional stimuli and two-dimensional stimuli. They, not unlike children with autism who lack Naming, must cope by nonverbal means.

NAMING, EMERGENT CATEGORIZATION, AND NONVERBAL RELATIONS

We think that the extensive work on relations between Naming and visual stimuli cited earlier suggest that Naming facilitates, or may be necessary for, categorizations that are essentially verbal in nature. Indeed, in almost all of the developmental studies on Naming, the responses have included categorizations of a verbal nature. However, Naming need not involve abstractions. For example, one learns the name of a person (''This is Bob'') or a pet (''This is my dog Bubbles''). But much of Naming involves abstractions, as in ''This is a rose, a mammal, a deciduous tree, a reptile, a triangle, a noun, a verb,'' to name a few examples. Naming is a likely a key cusp for all of these advanced categorizations. To understand the essence of observed phenomena, one must have Naming (i.e., respond as both speaker and listener) and not just the ability to tact or respond as a listener. Abstractions of a verbal nature are advanced incidentally by the Naming developmental capability. Without Naming for two- and three-dimensional stimuli, these advanced capabilities are difficult to acquire. We propose that when the joining of the observing and producing responses has verbal ramifications, as in certain verbal categorizations, Naming is the facilitator.

However, derived stimulus relations need not be verbal, as in the case of music, art, or dance, or in emergent relations that are in some way tied to evolved survival functions in nonhuman animals. However, verbal

relations do come into play in verbal analyses of art, music, or dance (Figure 6); however, the primary acts of art, music, and dance have their own reinforcement, and these are not verbal. For example, Greer and Lundquist (1976) demonstrated that high school students acquired abstractions for identifying musical forms from MEI. Perhaps creative performance in the arts or problem solving in nonhuman species involves higher order operant relations or emergent relations that incorporate joining of observing and producing responses such that novel and effective responding results.

Thus, it is possible that derived relations may be verbal or nonverbal. Perhaps this explains the discrepancy in the stimulus equivalence literature in which some emergent behavior involves processes of observing and producing that are not essentially verbal. Perhaps the contingencies of reinforcement are simply different, as when we discussed the joining of different types of observing and producing responses and the distinction between the reinforcement for each. In recent years, developmental psychologists and developmental comparative psychologists (Premack & Premack, 2003) have argued that humans have certain psychological ''modules'' that other species do not. An alternative explanation is that the observing and producing responses touted to be modules are simply subject to different phylogenic or cultural and social reinforcement conditions for the different species, along with different physiological and sensory capabilities. Serious neuroscientific analyses involving pre-Naming imaging in children who originally lack Naming and post-Naming imaging might test this. Indeed, this type of investigation may be the most efficient, if not the only, way to test the validity of f/MRI investigations directly (see Barnes-Holmes et al., 2005, for an example of this type of investigation and Dickins, 2005, for a thoughtful discussion).

WHENCE THE ORIGINAL REINFORCEMENT FOR NAMING?

What constitutes the source of reinforcement for the acquisition of the Naming capability? Horne and Lowe (1996), Lowenkron (1984, 1988, 1989, 1991, 1996, 1997), and Lowenkron and Colvin (1992, 1995) suggested that Naming is directly reinforced by the echoic product even if the echoic is covert. Horne and Lowe discussed the importance of a caregiver's role in reinforcing echoic behavior, suggesting that the accrued reinforcement for the echoic is derived from this history.

Lowenkron (1984) taught students to produce signed tacts and listener responses through a rehearsal procedure and provided evidence that the rehearsed sign was the stimulus control for signed tacts. Lowenkron (1997) proposed that the emergence of derived stimulus relations was a function of rehearsal of object selection as a simulation of the echoic and a history of differential reinforcement. In other words, controlling relations result from a history of differential reinforcement across multiple-exemplar experiences not unlike those found in several studies that resulted in Naming (Fiorile & Greer, 2007; Gilic, 2005; Greer, Stolfi, et al., 2005; Greer et al., 2007).

Another potential source of the reinforcement for Naming involves stimulus–stimulus pairing experiences like those used in the study by Longano (2008). Skinner (1957) characterized this as ostensive processes or ''ostensive learning,'' which involves the pairing of a vocal stimulus (potentially a conditioned reinforcer) with another neutral stimulus, such as an action with an object (Stemmer, 1996). Of course, the reverse may also occur. Stemmer (1973, 1990, 1996) proposed that most object tacts are learned through ostensive processes consistent with Skinner's point. Skinner also argued that children learn to become effective listeners through Pavlovian-type conditioning processes that set the occasion for the listener to respond to the verbal stimuli with conditioned reflexes (Keohane et al., 2006a; Skinner; Stemmer, 1990). Skinner suggested that individuals acquire novel speaker (tact) and listener responses by observing another individual manipulate the object while tacting the object. Individuals learn to become effective listeners and speakers as a function of the pairings. After exposure to the pairings, an individual can act as a listener by manipulating or using the object in a manner similar to that observed. In summary,

the pairings are suggested to have two effects (Skinner; Stemmer, 1990). First, they occasion the individual to learn effective listener behavior in response to the stimuli; second, the exposure and the history of reinforcement with the exposure allow the individual to acquire the tact for the stimuli, and therefore also to become an effective speaker (Skinner; Staats, 1968; Stemmer, 1973, 1990). Several studies have reported the emergence of the echoic as a function of stimulus–stimulus pairings (Esch, Carr, & Grow, 2009; Miguel, Carr, & Michael, 2001/2002; Sundberg, Michael, Partington, & Sundberg, 1996; Yoon & Bennett, 2000), suggesting the influence of stimulus–stimulus pairings on the emergence of parroting and the subsequent potential for the parroted responses to become echoics. These echoics are foundational to the tact speaker function.

As discussed earlier, Longano (2008) found that 1 of the 3 children for whom Naming did not emerge as a function of MEI did demonstrate Naming after he or she was required to echo across matching to sample and point to responses to training sets of stimuli. Increases in untaught speaker and listener responses (Naming) occurred for 3 participants, and Naming emerged for 1 of the 3 participants. One of the participants for whom Naming did not emerge then received visual and vocal stimulus–stimulus pairings; after this intervention, Naming emerged. In the final experiment, the stimulus–stimulus pairing procedure alone resulted in Naming for 3 other participants. Although echoic responding was not required in the final experiment, an increase in echoic responding was observed in the listener probes for 2 of the 3 participants following the stimulus–stimulus pairings, suggesting that the echoic acquired its reinforcement properties from the stimulus–stimulus pairings.

Thus, perhaps both the Pavlovian second-order conditioning and the echoic are involved, but at different stages. Horne and Lowe (1996) suggested that the caregiver's voice and sounds function as classically conditioned stimuli that have strong reinforcing effects on the child, so that when the child hears his or her own voice in the echoic, these sounds have reinforcing properties similar to those of the parents. That is, correspondence between what has been heard and what is said serves as a conditioned reinforcer, and in typically developing children this occurs very early (see Decasper & Spence, 1987, for evidence of this effect). Several studies have suggested that correspondence between the behavior of caretakers and children's unreinforced behavior may, in fact, be due to the conditioned reinforcement properties of correspondence itself (Gladstone & Cooley, 1975; Rheingold, Gewirtz, & Ross, 1959). It is possible that the source of reinforcement is the conditioned reinforcement for stimuli associated with either or both the spoken stimuli and the other observed stimuli. For example, conditioning print stimuli as reinforcers for observing and preference in young children who have not learned to textually respond resulted in accelerated acquisition of textual responses (Tsai & Greer, 2006). In this study, systematic pairing trials continued until children preferred books to toys and looked at books for 75% of 5-s interval observations of two consecutive 5-min free-operant sessions in which books and toys were available. In turn, when books were conditioned reinforcers for observing responses and the books were preferred, the acquisition of conditioned reinforcement for books was functionally related to accelerated acquisition of textual responses to printed words. Similar effects were found for conditioning visual stimuli on acquisition of visual–visual match-to-sample responding (Pereira-Delgado et al., 2008).

PRECURSORS THAT ALLOW THE DEVELOPMENT OF NAMING

In a study on very early development, Decasper and Spence (1987) reported that newborn children emitted auditory observing responses to their mothers' voices and not to other voices, suggesting that in utero conditioning of mothers' voices was responsible. Keohane et al. (2006a, 2006b) reported a functional relation between conditioned reinforcement for visual tabletop stimuli or auditory speech and accelerated rates of visual discrimination for severely developmentally delayed preschoolers (see also Keohane et al., 2009, and Dinsmoor, 1983, for related findings with pigeons). It does seem feasible that Pavlovian second-order

conditioned reinforcement for the stimuli involved in the observation experience for Naming may be responsible for the prerequisite conditioning of the echoic as a reinforcer. Indeed, perhaps emitting the correspondence itself is the conditioned reinforcer. That is, the acquisition of conditioned reinforcement for observing both speech and other observed stimuli is the initial developmental cusp.

Parroting may accrue from this initial conditioning. Parroting, however, is not verbal, in that it has no speaker function (see Skinner, 1957, p. 59, for the difference between parroting and echoing). But duplicating the sounds can initially reinforce speech sounds or singing, and hearing the sounds by speaker-as-own-listener results in automatic reinforcement. In this case, attention to the observed response that one produces results in within-the-skin listener reinforcement, perhaps because the correspondence between hearing and saying is already a conditioned reinforcer. Subsequently, when that parroted response works to mediate the environment for the speaker through another listener, the spoken response produces a verbal effect. The parroting response becomes an echoic. This change in function moves the response from nonverbal to verbal, because the response now acts to have the listener mediate for the speaker. Thus, the sequence involves one's producing response being reinforced by one's observing response, and then having the matching of the observed response as speaker-as-own-listener act in an operant function on another listener for the speaker's benefit. At this point, the history of echoic-to-tact or echoic-to-mand (at least two initial instances for each, Greer & Ross, 2008, argue) provides a history of reinforcement for attending to stimuli in speaker-as-own-listener repertoires. Hearing the overt or covert echoic is the immediate reinforcer for the component parts of Naming built on the initial conditioning experiences.

CONCLUSION

Naming leads to ''the process of becoming acquainted or of acquainting others with the essentials of an unfamiliar object or topic'' (*Oxford English Dictionary*, 2000, p. 206). In Naming and other more complex stages of verbal behavior, the speaker must also be acting as a listener to be truly verbal (Skinner, 1957, p. 34). Joining Naming to print then leads to more complex human verbal behavior, such as reading comprehension and the following of written algorithms, effective writing of algorithms, and the solution of complex problems under textual stimulus control (Figure 5).

Regardless of numerous remaining questions, the role of environmental experiences in the acquisition of Naming appears to be robust. Moreover, there seems to be a difference in the acquisition of Naming for two-dimensional and three-dimensional stimuli (Greer & O'Sullivan, 2007), and we think that there may be differences across different senses (olfactory, gustatory, tactile, and visual). It is even possible that there are differences in the coacquisition of other verbal operants, including autoclitics, intraverbals, and print stimulus control. Much remains to be studied, but it is apparent that Naming is crucial to more advanced complex human behavior, such as its relation to the educational prognosis of children and the development of an empirically based verbal developmental trajectory (Greer & Speckman, 2009). Clearly, the identification of and the wherewithal to induce Naming are major contributions of the experimental and applied analysis of verbal behavior to the study of language by linguists and neuroscientists, as well as the study of the evolution of language. Moreover, this contribution has important ramifications for the advancement of pedagogy and the treatment of language delays by speech therapists.

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