Actions and Names: Observing Responses and the Role of Multiple Stimulus Control in Incidental Language Acquisition

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ABSTRACT

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The present research focuses on the possible relation between observing responses and language acquisition. In the first of three experiments, preschool aged participants with and without disabilities were presented with the opportunity to observe multiple aspects of a stimulus. A Naming experience was created in which the stimulus was presented with visual and auditory characteristics, such that the participant heard the name of an object while observing an action demonstrated with the object. The dependent variables measured which of those aspects selected out the participant’s observing responses. The participants consistently acquired the actions associated with the objects, but produced fewer names as a speaker.

The second experiment used alternating treatments with single case design to analyze the responses to stimuli presented with and without actions. Unconsequated probe trials of the dependent variables measured whether the participant acquired listener and speaker responses for the name of a stimulus, and whether the presence of an action improved or hindered acquisition of those responses to the stimulus. In the experimental action condition, participants acquired fewer speaker and listener responses to the stimuli. The results indicated that the visual-motor (action) aspects of the stimuli selected out the participants observing responses over the auditory (name) aspects of the stimulus.
Consequently, the presence of an action hindered rather than facilitated incidental acquisition of names, suggesting the dominance of visual stimuli over auditory stimuli.

In the third experiment, participants were selected who acquired listener responses to the stimuli in the experimental action condition, but did not readily acquire the speaker responses. The participants were presented with multiple exemplar instruction (MEI), which provided rotated opportunities to receive reinforcement for responding to the stimuli with action imitation, listener responses, and speaker responses to the stimuli. Following mastery of the MEI intervention, participants acquired both speaker and listener responses to novel sets of stimuli in the experimental action condition. The results suggest that rotated opportunities to emit multiple responses to a single stimulus in the presence of reinforcement can result in a shift of stimulus control such that new observing responses emerge that were not present before. The results are discussed in terms of conditioned reinforcement, observing responses, and incidental language acquisition. Evaluated as a whole, the findings from these experiments indicate that when an individual is provided with a specific instructional history, he or she can acquire additional responses to a stimulus, beyond the speaker and listener, as a result of the Naming experience.
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“We don’t receive wisdom; we must discover it for ourselves after a journey that no one can take for us or spare us” Marcel Proust

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Dedication

To all the wonderful students that I’ve had the privilege of knowing – thank you for all that you’ve taught me.
CHAPTER I: INTRODUCTION AND REVIEW OF THE LITERATURE

Introduction

When comparing the early development of infants to the capabilities of a child at the age of three, it is amazing and seemingly impossible how much has been learned in such a brief period of time. Children are born with basic physiological capabilities and from that foundation their senses develop and integrate, which then enables them to observe, imitate, and learn from their everyday experiences. Development is not a linear progression; rather it is the intersection of multiple developmental cusps and capabilities (Greer, 2008; Greer & Keohane, 2005; Greer & Longano, 2010; Greer & Speckman, 2009; Keohane, Pereira-Delgado, & Greer, 2009). Their development progresses without direct intervention, as they learn to walk, talk, and successfully navigate their environment.

Research has focused on the capabilities of imitation, learning through observation, and indirect acquisition of language. The presence of these capabilities allows for the seemingly effortless learning that characterizes early childhood development (Greer, 2008; Greer & Keohane, 2005; Greer & Longano, 2010; Greer & Speckman, 2009; Keohane et al., 2009). But beyond these individual components, can we identify the necessary experiences that allow for the integration of these capabilities? Within a single experience, a child can acquire multiple responses, pieces of information, or forms of language. When a young child observes an adult using a hand mixer, this experience is an opportunity to learn that the object is called a mixer; the action is called mixing, and the physical manipulation of the object that results in mixing. Can the child readily learn all of the three components of the demonstration, or does he or she selectively attend to one aspect?
And most importantly, how can we facilitate learning such that singular experiences can result in multiple repertoires?

In order to summarize the relevant research across multiple disciplines that bear on the topic, I will review literature and research on the role of conditioned reinforcement in language acquisition, evolutionary theories of language and gesture, imitative behavior, variations in the acquisition of object names and object actions, language acquisition, and research on the critical capabilities required for incidental learning. The research and theory regarding the role of actions in language acquisition requires a multi-disciplinary review of literature and synthesis of the seemingly divergent approaches.

**Precise Terminology**

A challenge in integrating the findings and theories of multiple disciplines is the variations and conflicts that exist among their terminologies. Although two branches of research may describe the identical phenomenon, the use of different scientific terminology can easily create the illusion of divergent meanings and muddy the waters of scientific discourse.

A critical component of scientific discourse is a set of precise terminology that is consistently used across experimenters. Vague, imprecise, or varied language allows for discrepancy and miscommunication, eliminating all possibility of experimental control. The development of a language, or verbal behavior of a science, is necessary in order to accurately describe events as a speaker and to acquire new research-based practices as a listener, and most importantly, to produce replicable procedures (Greer, 2002; Skinner, 1957).
Skinner (1957) differentiates the verbal behavior of the scientist from that of the layperson, “because of the emphasis on practical consequences … the test of scientific prediction is often, as the word implies, verbal confirmation. But the behavior of both logician and scientist leads at last to effective nonverbal action, and it is here that we must find the ultimate reinforcing contingencies which maintain the logical and scientific verbal community” (p. 429). Accurate tacts ensure consistency when describing the events to another member of the scientific community (Greer, 2002). Mastery of the verbal behavior of the science then allows for the development of new verbal behavior based on research findings. Skinner explains that the intraverbal repertoires of the scientist are comprised of verbal behavior with a history of successful action, and much of the foundation of scientific training requires the acquisition of definitions and facts. Given a foundation of scientific verbal behavior, new and increasingly precise verbal behavior can be developed based on empirical findings (Skinner, 1957).

Precise verbal behavior allows for communication within the scientific community, but discussion alone serves no purpose. Rather it is the application of the verbal behavior of the science to experimental questions that is the ultimate function of scientific terminology. Skinner (1957), explains, “empirical science is only in part concerned with the construction and confirmation of verbal behavior. In broader terms, it is a set of practices, which are productive of useful behavior. A large part of this is verbal and a part of this, in turn, constructed’” (p. 428).

In the science of behavior, a precise vocabulary of verbal behavior has been fine-tuned, allowing for clear communication across experimenters and practitioners. The present paper draws from the theories and research of many disciplines, and in an effort to
synthesize and integrate the often divergent vocabularies, the terminology of the science of behavior will be used as the primarily language and equivalent terminology will be provided for the language of the other disciplines.

**Review of the Literature**

**Stimulus Control**

Although much of the research in the field of behavior analysis is focused on the shaping of behavior as a result of consequences, antecedent stimulus control is pulled along by the consequences. “Stimulus control is a transmission device: It is nature’s way of bringing past reinforcement to bear on current behavior “ (Dinsmore, 1995, p. 52). If a stimulus is present when a response is reinforced, that stimulus acquires an increased probability of control over the response. In this case the environmental history is in control, which includes both the physiology of the individual in combination with the cumulative history of contingencies (Skinner, 1974). Skinner (1975) explains that the shaping of phylogenic behavior can be related to the development of new stimulus control, such that “an organism inherits a tendency to behave in a given way in the presence of given stimuli” (p. 120).

When we look closely at antecedent stimulus control, it becomes apparent that it assumes a critical role in our lives. Stimulus control can determine survival. For example, if the visual presence of fins in the water evokes a reluctance to enter the water, then stimulus control has been established through a history of negative consequences. On a more positive note, finding green plants in an otherwise arid landscape would indicate the presence of water. In this case, the positive consequence of finding water has previously
occurred in the presence of greenery. We stop at a red light and go at a green; the color of the stoplight has stimulus control over our driving behavior. It allows us to behave in accepted ways across various settings; our behavior in a theatre is different from that in a stadium. Stimulus control allows the individual to accumulate a history of contingencies, and respond appropriately in the presence of the stimulus on future occasions.

Stimulus control explains why we orient to certain stimuli in the environment and ignore others. Stimulus control requires contact with the antecedent stimulus, and that contact is made through one or more of the five senses (Dinsmoor, 1983, 1985, 1995). The responses that create contact with the antecedent stimulus are termed observing responses (Wykoff, 1952). When a stimulus becomes paired with a reinforcer, the stimulus then becomes a conditioned reinforcer that maintains the observing behavior (Dinsmoor, 1983, 1985, 1995; Holland, 1951).

**Observing Responses**

“As organisms living in a complex environment, we are affected by multiple stimuli from moment to moment. As a result (of our evolutionary history), we have developed a singularly efficient method of selecting and attending to stimuli so that we can affect some kind of control over the environment in which we live” (Keohane, Luke, & Greer, 2008, p. 23). Organisms are continuously exposed to a variety of stimuli, rather than to a single stimulus, and some of those stimuli are more likely to be attended to than others (Colavita, 1974). We respond to a variety of multi-sensory stimuli in the environment and must selectively attend to relevant aspects while filtering out unnecessary information. This selective attention has been termed observing responses, which are defined as operant responses that are selected out by consequences. An observing response
can be simply described as selectively attending to stimuli based on a history of reinforcement or punishment for attending or not attending to stimuli (Keohane et al., 2008). The importance of an individual sound, smell, sight, taste, or tactile experience is based on both the context and the cumulative history under which stimulus control is learned. A car horn in traffic warrants attention while a car horn on television does not. It is the capability to have salient stimuli select out our attention that determines our experiences in the world (Keohane et al., 2008).

Since observing responses are selected by consequences, calculated manipulation of consequences can create new observing responses or modify existing ones. Researchers have found that systematically pairing reinforcement with attending to environmental stimuli can induce reinforcement for observing responses to the stimuli that were not previously present (Dinsmoor, 1983; Greer, Becker, Saxe, & Mirabella, 1985; Greer, Dorow, & Hanser, 1973; Holland, 1958; Keohane et al., 2008; Longano & Greer, 2006; Nuzzolo-Gomez, Leonard, Ortiz, Rivera, & Greer, 2002; Pereira-Delgado, Greer, Speckman, & Goswami, 2009; Tsai & Greer, 2006). In these experiments, stimulus-stimulus pairing procedures were successfully implemented to expand individuals’ community of reinforcers, by teaching children to prefer previously non-preferred stimuli as conditioned reinforcers. Since the 1940’s, research has consistently shown that stimuli can acquire reinforcing characteristics through the pairing of the neutral stimuli with a previously conditioned or unconditioned reinforcer. The principle of conditioned reinforcement has been an important area of research in human behavior (Williams, 1994). Through conditioned reinforcement, new stimuli select out the individual’s attention, creating new observing responses. These observing responses can be related to music
Observing responses describe the operant behavior of orienting to a stimulus using one or more of the senses of sight, touch, smell, taste, or hearing (Holland, 1958; Keohane et al., 2009). In an environment filled with competing stimuli, observing responses act as a filter to select out what is relevant. For this reason, observing responses have a critical role in language acquisition, directing one’s attention to the verbal behavior of others as well as the referent object or action. Observing and discriminating the sound of voices is a foundational prerequisite to the development of verbal behavior. Responding to human voices is essential to the acquisition of both listener and speaker repertoires (Pelaez-Nogueras, Gewirtz, & Markham, 1996). Typically developing infants will turn towards the source of a sound, and this orientation to a voice facilitates learning and communication skills (Mill & Melhuish, 1974). But, “if voices do not select out or attract the child’s attention, the child is unlikely to be prepared to discriminate vowel-consonant
sounds and other aspects of speech that come to have listener and speaker effects” (Keohane, et al., 2009).

Typically developing children seem to acquire aspects of their parents’ language without special instruction or direct reinforcement (Bijou & Baer, 1965; Moerk, 1990; Mowrer, 1954; Novak, 1996; Schlinger, 1995). The process of automatic reinforcement has been used as an explanation for this outcome, which begins with the pairing of the sound (i.e., the sensory product of the response) with an established form of reinforcement (Skinner, 1957; Vaughan & Michael, 1982). Schlinger (1995) suggests that typically developing children constantly hear the sounds produced by the verbal community while they are being fed and caressed, and during other interactions. Numerous pairings between adult vocal sounds and reinforcing stimuli might account for the development of these sounds as forms of conditioned reinforcement (Greer & Speckman, 2009). Through these experiences, a child learns to select out adult vocal sounds, creating a foundation for language learning.

Not unlike the observing response for voices, another interrelated observing response develops in infancy that results in selective attention to movement. Beginning at birth, reinforcing stimuli associated with the caregiver, such as sounds, contact, and nutrition, are paired with her movements. The infant begins to selectively attend to those movements (Greer & Speckman, 2009; Schlinger, 1995; Staats, 1968). Adult gestures and actions become relevant stimuli in the environment that select out the infant’s attention.

Essentially, through a series of pairings, the sounds of adult voices and their movements become selected out as observing responses early in development. These
fundamental observing responses of looking and listening are vital to the development of more complex repertoires (Choi, 2012, Du, 2011; Greer et al., 2011; Howarth, 2012; Keohane, Luke, & Greer, 2008; Maffei-Lewis, 2010; Moreno, 2011). These topics will be discussed in greater detail in later sections, but for now it is sufficient to explain that the establishment of observing responses for voices and movement are an essential initial prerequisite for acquiring complex repertoires.

**Evolutionary Perspectives on Gesture and Language**

Before looking at the development of complex repertoires within the lifetime of the individual, it is informative to trace the parallel development across human evolution. We will first trace the progression of communication from our primate ancestors to modern day humans and then the somewhat parallel process from infancy to adulthood.

**Phylogenesis.** Not unlike the ontogenetic development of language within an individual’s lifetime, the evolutionary development of language follows a similar trajectory. Genetic research has suggested that the gene for articulate human speech, FOXP2, only became present in the human population an estimated 500,000 years ago (Krause et al., 2007). Ongoing research into the role of the FOXP2 gene has found that its relation to language is not as clear and direct as initially believed, but instead has a more fundamental role brain development. It appears to have a role in learning the motor movements integral to producing speech and language. The FOXP2 gene is found in most vertebrates, but the variation in the human form suggests its importance in vocal control and role in the evolution of language (Enard, 2011).
Marcus (2007) explains the importance of genetics, but underscores the presence of other capabilities:

Language is probably a patchwork of a dozen or so capacities borrowed from ancestors, ranging from tools for imitation and social understanding to tools for analyzing sounds and sequencing information … I would argue that language could not have evolved so quickly … without this sort of broad inherited base (as cited in Kenneally, 2007, p. 223-224)

Due to a lack of physical evidence of the organs and structures involved in language production, researchers must rely on fossil records of the jaws and oral cavity of earlier hominids and use reconstructions based on the physiology of modern day human and non-human primates (Crystal, 2005). It is unlikely that Australopithecus had the physiological capability to speak in 4-5 million BC, while the Neanderthal of 70-35,000 BC had a vocal tract comparable to that of a modern day infant. Based on this evidence, Neanderthals would have been able to produce vocal sounds beyond those of the modern non-human primate, although insufficient to form a vocal or spoken communicative system. It is the evolutionary stage of the Cro-Magnons (35,000 BC) in which the skeletal structures and physiological capabilities for speech mirror those of modern day humans (Crystal, 2005).

Although the primitive vocal systems of early hominids precluded the possibility of a purely vocal language, their advanced cultural development indicates the presence of an efficient communicative system to transmit information across individuals and generations. Given the late development of this capability, it becomes clear that vocal communication was not the primary method of communication for much of human evolution (Tomasello,
Most likely an elaborate gestural system was used to communicate (Crystal, 2005; Kenneally, 2007). Tool use was a pivotal cultural skill, and it has been suggested that learning to use tools and learning language are localized in the same region of the brain and that both gesture and tool use requires sophisticated use of the hands (Crystal, 2005). The evolutionary shift to bipedalism is theorized to have had an important role in evolution of language in that the shift in posture was fundamentally important to free the hands for gesturing. Based on fossil evidence, in the evolutionary timeline, bipedalism preceded the enlargement of the human brain (Armstrong & Wilcox, 2007; Kenneally, 2007). As the size of the human brain increased it is important to note that the neocortex and cerebellum became significantly larger in humans when compared to other primates. Language is attributed to neocortex while the coordination of complex movement is attributed to the cerebellum (Gibson & Jesse, 1999).

Mirror neurons in the brains of nonhuman primates have been discovered in the premotor cortex of monkeys and have been observed to fire both when a monkey observes and when he performs certain specific manual activities (Rizzolatti & Arbib 1998). The mirror neurons are proposed to be analogous with the Broca's area in human brain anatomy, an area related to speech. Using brain imaging, Broca’s area in humans can be divided into Brodmann areas 44 and 45. Area 44 is activated by gesture and movement, while area 45 is activated by signed or spoken language. Within the brain, there is a clear overlap between action imitation and language (Corballis, 2010). These findings suggest that the brain region in humans related to speech may have developed from the area in the primate brain related to manual activities and gestures.
In an interview with Kenneally (2007), Arbib proposes that multiple layered stages were required for language evolution, which he refers to as an ascending spiral. Initially, early humans had the capacity for complex imitation in order to acquire novel skills. In other areas of research, this is referred to as generalized imitation (Baer, Peterson, & Sherman, 1967; Baer & Sherman, 1964). Arbib adds that, at the same time, a gestural communication system combined with vocalizations, all of which was supported by the mirror system. Speech developed through a scaffolding of gesture, pantomime, signs, and sounds (as cited in Kenneally, 2007, p. 246). Duplicative behaviors, including imitation, are discussed in detail later in the paper in relation to language acquisition.

Cross-modal association describes the capability to combine vision, hearing, and somatosensory input into higher order concepts and images. Armstrong and Wilcox (2007) explain further, that the cross modal association occurs in the cortex of the parietal lobe and surrounding areas of the brain, referred to as the parietal/occipital/temporal area (POT). This area of the brain has grown dramatically over the course of human evolution. For modern day humans, cross-modal association allows us to respond to and integrate the countless stimuli in the environment.

But beyond the physiological capabilities for developing language, one must analyze language from a perspective of its function. As a species, humans developed adaptive behaviors that increased the likelihood of survival. When looking at language through that lens, it is not unreasonable to suggest that developing a vocal language facilitated the human activities that ultimately lead to survival. In 1957, B.F. Skinner introduced the idea that language is a behavior shaped by reinforcement. He argued that language can be affected by manipulating reinforcement and it can be studied based on its
function. In the case of human evolution, vocalizations initially emerged from the presence of physiological capabilities, but developed into a language as a result of improved outcomes for the individual and species as a whole.

According to Tomasello (2008) the development of human language is rooted in cooperative communication, a characteristic exclusive to humans. Unlike other primates, humans create joint goals and complementary goals in collaborative activities. In behavioral terminology, this is referred to as a yoked contingency, in which the reinforcement for one member of a dyad or group is interdependent on the behavior and reinforcement of the other members (Davies-Lackey, 2005; Greer & Ross, 2008; Stolfi, 2005). Evolutionarily, a collaborative activity such as hunting necessitated a joint goal and a means of communicating the roles (Tomasello, 2008). Learning foraging and tool-making skills requires joint visual attention to the actual task, as well as a means to communicate additional information as the complexity of the task increases. In this case, when the hands are involved in a task, gestural language would present a disadvantage, while vocal language could easily expand upon the visual demonstration (Armstrong & Wilcox, 2007). There was clearly an evolutionary advantage to the incorporation of vocal language into a gestural and visual system.

In comparison to apes, humans tend to focus more on the specific actions entailed in affecting an outcome, rather than just the outcome itself. The need to observe and imitate actions is critical to human learning of skills such as tool making, but also for learning gestural means of communication (Tomasello, 2008). Beyond these concrete functions of imitation, Tomasello also adds that imitation can create similarities within the group and develop social norms. The presence of an imitative repertoire is critical to social
learning, particularly in the case of conventional communication, using arbitrary signs, which must be taught and learned in order to have meaning or function. Imitation also underlies the standardization of signs, which marks the emergence of a language (Tomasello, 2008).

While it may seem that the shift from an action or gesture-based means of communication to vocalizations is a dramatic one, it is more likely that it was the product of gradual and systematic pairings of the established gestures with vocal sounds (Tomasello, 2008). Initial vocal sounds may have been those indicating emotional responses, such as the specific fear calls made by monkeys observing a predator. Control over those vocalizations would then allow for purposeful imitative sounds, such as the specific sounds of the approaching predator, which then establish an independent meaning by pairings with an accompanying gesture (Tomasello, 2008). Once the vocal sounds acquire a meaning independent of the gestures, those sounds acquire a function and become an effective means of verbal communication.

There is no singular gene or physiological structure that is responsible for the evolution and production of language. It is comprised of a complex combination of traits and process that have evolved over time. But despite the human capability for spoken language, we do not speak until we are taught to do so from the “modeling” of other speakers (Kenneally, 2007). It has been established that human evolution has created a foundation for language learning, but we must next look at the emergence of language within the lifetime of the individual to fully understand this complex process.

**Ontogenesis.** Children are not born with fully functional imitative repertoires and language, but instead acquire these behaviors through a series of interactions with their
environment and developmental physiological changes. Understanding of human communication does not begin with spoken language, rather it requires analysis of communicative acts predating speech such as gestures and pantomiming of actions. Gestural communication emerges early in the developmental process of human infants, not unlike the earlier emergence of gestures which predated conventionalized languages in human evolution (Tomasello, 2008).

The earliest act of human communication is the infant’s use of pointing to make requests and share experiences. It is unknown whether the act of pointing itself evolves or emerges from another behavior or whether it is learned from others as an imitative behavior (Tomasello, 2008). After pointing, but before vocal language becomes the primary mode of communication, young children often use gestures to refer to objects (Acredolo & Goodwyn, 1985; Namy & Waxman, 1998). During the second year, the next developmental acquisition is the use of conventional gestures such as waving to greet someone or shaking one’s head to indicate “No.” These conventionalized gestures are learned from adults, through imitation. The level of complexity in gestural communication is referred to as creative iconic gestures, such as pantomiming. When the child enacts a familiar action for communicative purposes, the behavior requires prerequisite skills of imitation, simulation, and symbolic representation (Tomasello, 2008). Kenneally (2007) outlines the co-occurrence of gesture and vocal speech in child development, explaining that language first emerges as gesture, followed by a combined usage of words and gestures, and finally vocal speech that can function as a means of effective communication, with or without the use of gestures. The development of language from gesture to vocal speech is not simply linear; gesture does not become speech, and speech does not replace
gesture. Rather the two co-occur and one can be used to enhance the meaning of the other (Keneally, 2007).

Tomasello (2008) explains that gestures serve two primary functions; first, to direct the attention of another individual to an event, object, or person in the immediate environment, and second, to pantomime or “act out” to refer to an event, object, or person that is not visible in the present environment. As human adults reliant on vocal communication, we find ourselves reverting to these acts of gestures and pantomiming when we are unable to vocalize due to laryngitis or in a loud environment. In these situations, we rely on the common foundation that all communicative humans share in gestures. Tomasello adds that the success of these forms of non-vocal communication relies on the shared cumulative experience of the parties involved, or “common ground,” that allows the observer to determine the referential and social intention of the actor. From the behavioral perspective, Skinner (1957) explained this as a common verbal community in which a history of reinforcement has assigned meaning to arbitrary words or gestures. In the case of sign language, some gestures are referred to as iconic, meaning that they are reflective of actual events or actions in the external world. These iconic gestures can be interpreted by others based solely on the history of shared experiences (Crystal, 2005). But the majority of sign language is comprised of gestures that are assigned arbitrary meaning, not unlike spoken language. The relationship between the object “shoe” and the word shoe is arbitrarily applicable and could have been assigned any other name. In fact, these same objects are assigned different names across different languages, dialects, and communities (Quine, 1960).
According to these theories, pointing and gestures can function as communication provided that there is a history of shared experiences (Crystal, 2005; Quine, 1960; Skinner, 1957; Tomasello, 2008). In social-pragmatic theories of language acquisition, shared experiences play a prominent role in the acquisition of spoken language (Tomasello, 2008). Language develops through shared interactions with adults in which both the adult and child are attending to an activity and the adult is speaking about the activity and objects involved (Greer, Stolfi, Chavez-Brown, & Rivera, 2005; Tomasello, 2008). Developmentally, the presence of joint visual attention to objects correlates strongly with children’s initial acquisition of words. When a mother uses language within a joint relational frame, children under the age of three are more likely to acquire those words when compared to similar scenarios outside of the joint attentional frame. The joint attentional frame has been referred to as a “hot spot” for language acquisition (Tomasello & Farrar, 1986; Carpenter, Nagell, & Tomasello, 1998). Interestingly, as the child acquires spoken language, gestural forms of communication become less prominent, but the act of pointing persists. Tomasello suggests that language replaces gestures, but pointing can be used in concert with developing language to expand meaning. Pointing can also be used by the child to recruit and direct the attention of the adult, initiating a joint attentional frame, which creates the opportunity for language acquisition. It is not unusual to see fully articulate children or adults pointing to some aspect of the environment to ask a question or make a statement, where on the other hand it would be quite odd to observe those same individuals “acting out” what they are trying to communicate.

Duplicative Behavior
Duplicative behavior is a critical component in the development of verbal and social behavior. It describes both observation and production behaviors, in which a behavior selects out the observing responses of an individual who in turn “matches” the observed behavior. Duplicative behaviors can manifest in various forms, for example see-do, hear-say, see-draw, hear-sing (Greer & Speckman, 2009). One might observe a dance movement and duplicate its production or hear a song and duplicate the sounds. See-do requires “(a) seeing someone perform a response, (b) emitting the response, and (c) observing the visual correspondence between one’s own response and the response of the other” (Greer & Speckman, 2009, p. 455). The duplicative response of see-do, or imitation, becomes a three-term contingency in which the correspondence between the observed behavior and the imitative production of the behavior functions as the reinforcer. The duplicated behavior matches the model, or it does not.

In the case of hear-say, or echoic behavior, the correspondence cannot be observed visually and instead must be observed aurally. Only the outcome, or speech product can be observed, and the physiological imitative process is obscured from view (Greer & Speckman, 2009). In this case, the duplicative behavior is best described as “emulation,” in which only the product can be observed without the benefit of observing the process (Greer & Speckman, 2009). Echoic behavior is one of the first steps in becoming vocally verbal.

Another distinction between the see-do and hear-say responses lies in the source of reinforcement. Reinforcement for the see-do response is immediately observable and automatic; the correspondence serves as the reinforcer (Du & Greer, 2013; Greer & Speckman, 2009). For the hear-say response, the speaker behavior is mediated by a
listener such that correspondence alone cannot function as the reinforcer for verbal behavior (Greer & Speckman, 2009; Skinner, 1957). When looking at duplicative responses, it is the source of reinforcement that differentiates these behaviors. The see-do and hear-say responses are integral in development, allowing the individual to observe the actions and communicative behaviors of others in the verbal community and subsequently reproduce those same behaviors. Duplicative responses allow us to learn from example, rather than from direct consequences.

**Imitation.** Imitation is a crucial step in development that underlies the acquisition of communicative behavior. Imitation of bodily movement is necessary for gestural communication and vocal imitation is the initial step in the production of language (Greer & Speckman, 2009). Children acquire skills by observing and copying what others do, a behavior referred to as social learning (Nielsen, 2006). Imitative behavior is an almost exclusively human adaptation that is a necessary foundation for learning. By duplicating the visually observed actions of others, one can learn new behaviors without costly trial-and-error. Imitation describes behavior that is an exact duplicate of that demonstrated by a model (Call & Carpenter, 2002). Tomasello (1990) defines imitation as the duplication of not only the goal, but also the specific actions demonstrated to achieve that goal. Imitative responses are topographically identical to the modeled behavior, meaning that they appear to have point-to-point correspondence with the model.

True imitation describes the acquisition of behavior by copying the motor movements of a demonstrator’s behavior (Call & Carpenter, 2002). At the core of imitative behavior is observation. The behavior demonstrated by a model provides many sources of information for the observer, whose attention is selected out by the goals,
actions, or results. The goal is the demonstrator’s aim, the action is the motor movements to produce the results, and the results are the environmental changes produced by the actions. According to the researchers, both the actions and results are directly observed, while the goal must be inferred based on the other pieces of information (Carpenter, 2006).

In imitation research focused on social learning, there are clear developmental differences that have been observed. Infants, by the age of 14 to 18 months, copy other’s actions, goals, and results (Call & Carpenter, 2003). Infants older than 12 months seem to be predisposed to attend to and duplicate actions, which may lead to the discovery of the results and goals of a demonstrator’s behavior. Researchers have suggested that by copying actions, infants may learn how objects work, how to produce environmental changes, and causality, which in turn can contribute to an understanding of goals (Call & Carpenter, 2002). For example, as an adult, one might duplicate the steps of cooking that we observed a friend or relative make. After rolling the dough in flour, it becomes obvious that it prevents stickiness. Without an explanation of the purpose of behaviors, imitating the actions and observing the consequences is an alternate method of learning why. Infants cannot benefit from explanation, so imitation and observation of the results can be a more effective means of learning when compared to trial-and-error.

Other variations have been found across different ages and developmental stages. Horner and Whiten (2005) found that 3-year-old children would imitate even obviously irrelevant steps towards a goal when those steps are modeled by an adult. Similarly, Tennie, Call, and Tomasello (2006) found that 18 and 24 month-old children were more likely to exactly duplicate the actions of the model while the 12-month-old children did not. Children aged 28-32 months consistently imitated the actions of a demonstrator with point-
to-point correspondence despite the fact that the behaviors were unsuccessful at achieving a goal (Call, Carpenter, & Tomasello, 2005). Even at the ages of 3 and 5, children will imitate obviously irrelevant behaviors demonstrated by an adult model (McGuigan, Whiten, Flynn, & Horner (2007). This research is cited to underscore the capability and tendency of young children to imitate adult behavior. Even in cases where the behavior includes clearly unnecessary steps, the children will imitate every step. Imitation is a critical first step towards learning independent behavior. Based on this research, it cannot be said that children would continue to repeat irrelevant steps after multiple attempts. In fact it would stand to reason that initial imitation is necessary to learn to achieve an outcome, and after multiple attempts the child will modify and streamline the behavior until it is both effective and efficient.

**Development of imitative behavior and generalized imitation.** Children are not imitative at birth; rather this capability emerges gradually as a product of conditioned reinforcement and naturally occurring behavior, according to the Verbal Behavior Developmental Theory (Greer & Speckman, 2009). Based on analysis of data across many disciplines, Greer and Speckman outline a behavior analytic theory of verbal development. They propose that the experiences during infancy shape imitative human behavior. Automatic reinforcement occurs when the effects of the behavior itself become reinforcing as the result of the individual’s history of reinforcement (Greer & Speckman, 2009). Imitation is the joining of observing and producing responses, which emerges as a product of experiences beginning at birth.

Based on the findings of DeCasper and Spence (1987), Greer and Speckman (2009) theorize that even before birth, the mother’s voice is paired with feeding in utero, which
conditions the mother’s voice as a reinforcer. Newborns orient towards their mother’s voice, and as vision develops, the sound of her voice becomes paired with her face. Through all of the senses, the child begins to observe the sights, smells, tastes, sounds, and feel the world around him or her (Greer & Speckman, 2009). The pairing of a reinforcer, initially nutrition, with various features of the mother results in conditioned reinforcement such that the mother becomes reinforcing. The infant orients towards her voice, looks at her face, and watches her movements. The accumulation of conditioned reinforcement for observing responses becomes paired with the actions of the mother. From these experiences, conditioned reinforcement is established for the correspondence between what is observed and what is produced (Greer & Speckman, 2009). The caregiver is reinforcing, so the infant observes and imitates the observed behaviors, most likely unintentionally at first. The correspondence between observing and producing becomes conditioned, and imitative behavior emerges. The observation and production responses for imitation require that the child sees the behavior, emits the same behavior, and observes the visual correspondence between her own behavior and the behavior emitted by the model.

Generalized imitation describes fluent imitative behavior in which the individual imitates the behavior of others without direct prosthetic reinforcement, such that the imitated responses are automatically reinforced. In generalized imitation, when novel non-reinforced behaviors are demonstrated, the individual imitates with point-to-point correspondence despite the lack of direct reinforcement. When an individual imitates behavior without direct reinforcement, it is referred to as generalized imitation. In this case, the response class of imitation has been reinforced. Baer and Sherman (1964) studied the role of social reinforcement in imitative behavior by reinforcing imitative
responses and measuring the strength of the unreinforced imitative responses using a puppet as both the model and source of social reinforcement. The puppet modeled and reinforced certain behaviors, which the participants readily imitated with point-to-point correspondence. The dependent measure was bar pressing, which was topographically dissimilar to the previously reinforced behaviors. The model demonstrated the behavior, but never directed the child to imitate or reinforced the bar pressing behavior. The participants imitated the bar pressing behavior without social reinforcement. The researchers suggest that in a child’s life, many opportunities are presented in which imitation of a model’s behavior produces reinforcement. An instructional history of reinforcement for imitation can result in the imitative behaviors themselves becoming reinforcing, producing generalized imitation. Greer and Longano (2010) expand on this, adding that through a history of reinforcement, correspondence between observing and producing becomes a conditioned reinforcer.

But in typically developing children, generalized imitation is not induced; rather it emerges from a history of observation and pairing of reinforcement. Imitative behavior appears to be reinforced by social approval, either in the immediate environment or as a culmination of a history of conditioned reinforcement. Children imitate because the imitative behavior or the correspondence between “see and do” functions as a conditioned reinforcer. When Greer and Speckman (2009) outlined the role of imitation in Verbal Behavior Developmental Theory, an underlying component of early development is the pairing of existing reinforcers with experiences and behavior. Initially, as a product of in utero pairing, the mother’s voice is a reinforcer for observing. When her voice is paired with observing her face, eye contact becomes a conditioned reinforcer. It is reasonable
then to conjecture that once these observing responses become conditioned as reinforcers, both observing and imitating the movements of the mother can also become conditioned reinforcers.

In recent research on the emergence of generalized imitation, Du and Greer (2013) taught children with autism imitative behavior in two conditions, one in which the student faced the teacher and another in which both the student and teacher faced a mirror. In comparing the two groups, the results showed that mirror instruction facilitated the acquisition of generalized imitation. A likely explanation is that the non-mirror participants were simply reinforced for the operant behavior of imitating, while the mirror participants received pairing of reinforcement with observing the correspondence of their own imitative behavior in the mirror. Du and Greer explain that conditioned reinforcement for correspondence between seeing and doing is the source of generalized imitation. Similar to Baer et al. (1964), in generalized imitation, the correspondence of the imitative response itself becomes a reinforcer. Du and Greer outline the possible conditioning process in which accurate “see-do” responses were reinforced with edibles, praise, and physical contact during the instructional sets for imitation, which created a pairing between reinforcement and the “see-do” response. Many other studies have found that this carefully constructed pairing procedure ultimately results in the behavior itself becoming its own reinforcer. These stimulus-stimulus pairing procedures have been successfully used to expand individuals’ community of reinforcers, by teaching children to prefer previously non-preferred stimuli (Greer et al., 1985; Greer et al., 1973; Greer, Dorow, Wachhaus, & White, 1973; Keohane et al., 2008; Longano & Greer, 2006; Nuzzolo-Gomez et al., 2002). Along the same lines of research, studies have found that the
stimulus-stimulus pairing procedure was effective for inducing cusps and capabilities, which then result in accelerated learning (Longano & Greer, in press; Maffei-Lewis, 2011; Greer et al., 2011; Pereira-Delgado et al., 2009; Tsai & Greer, 2006).

In a recent and related experiment, Moreno (2011) used the mirror not only to induce generalized imitation, but also measured the effects on the acquisition of functional behaviors taught through imitation. The results indicated that imitative instruction in the mirror successfully induced generalized imitation, in which the correspondence between see and do became a conditioned reinforcer. Again, the consistent pairing of reinforcement with observing oneself in the mirror while duplicating physical actions appears to have shifted operant imitative behavior to a generalized class of imitation whose reinforcing properties are derived simply from correspondence. But beyond the emergence of generalized imitation, Moreno (2011) found that the participants were able to learn in ways that were not possible prior to the intervention, specifically by observing and imitating a demonstration of teacher behavior to acquire new repertoires. Following this intervention, the participants acquired a developmental milestone critical to learning, the see-do repertoire. This repertoire can be characterized as a developmental cusp, which is also a capability, in that the acquisition of new capabilities allows for the acquisition of new operants that were not possible before (Greer & Ross, 2008).

Rosales-Ruiz and Baer (1997) define behavioral cusps as behavioral changes that subsequently bring the individual’s behavior into contact with new contingencies that were not possible before. When the acquisition of a cusp allows for the student to learn in new ways that were not possible before, it is then called a verbal developmental capability (Greer, 2008). A cusp allows for new learning opportunities and accelerated learning.
while a capability is a cusp that in addition, also allows the organism to learn differently and opportunities to learn increase exponentially (Greer, 2008; Greer & Ross, 2008; Greer & Speckman, 2009). Hayes, Barnes-Holmes, and Roche (2001) describe generalized imitation as an overarching operant class, in that the individual can imitate, not specifically taught behaviors, but rather any behavior observed. A relationship is established between observing a behavior and duplicating those movements through a history of multiple exemplar experiences with imitative behavior paired with reinforcement. Selective imitation is a critical first step in human development, but it is the leap into generalized imitation and its unlimited applications to learning that allows for the incredibly rapid acquisition of repertoires that characterizes early child development.

**Imitation of Object Actions and Acquisition of Object Names**

It is clear that imitation emerges early in development, long before the acquisition of functional spoken language. Imitative behavior allows a child to learn conventional gestures, such as waving hello or shaking one’s head to indicate “yes” or “no” (Tomasello, 2008). Until the development of spoken language, these conventional gestures and acts of pantomiming constitute the communicative vocabulary of a young child. Looking at later stages of development in which children have acquired spoken language, researchers have questioned whether the initial advantage of imitation over language is maintained or language replaces imitation and becomes dominant. For example, when simultaneously presented with an action and name for an object, does the child learn one more readily than the other? Researchers have focused their attention specifically on the acquisition of actions with objects in comparison to acquisition of object names.
When taught either arbitrary object names or object actions, children between 18 and 40 months old were able to demonstrate more object actions when compared to object names. With respect to object names, the participants had more correct responses for comprehension, or listener responses, when compared to speaker responses (Hahn, 2005). In follow-up series of three experiments, Hahn and Gershkoff-Stowe (2010) examined the relationship between acquisition of object names and object actions, comparing both receptive and productive responses. With two and 3 year old participants, object names were first learned receptively, (i.e., responding as a listener) then productively (i.e., responding as a speaker). Actions on the other hand, were acquired predominantly as production responses, in which the participants imitated the actions they had observed the experimenter perform with the objects rather than selection responses in which the participants were asked to select the object that corresponded with a demonstrated action. Overall, the participants produced few object names, but were able to produce nearly all of the actions. The researchers conducted a subsequent experiment with four and 5 year old participants, in which actions and object names were taught simultaneously. Again, the actions were learned at a higher rate as compared to the names as production responses. Interestingly, the names were learned as listener responses, but not as a speaker, such that the participants could select the specified object when it was named, but did not produce the name of the object when it was presented. Replication of this experiment with adults yielded comparable results. These results suggest that the processes involved in learning names and actions for objects do not drastically change with age and development, without direct intervention (Hahn & Gershkoff-Stowe, 2010).
Childers and Tomasello (2002) published similar findings for 2 ½ year old children, comparing the acquisition of nouns, verbs, and actions for novel objects. Listener responses requiring the selection of the named stimulus were consistent across nouns, verbs, and actions, but significant differences were found for speaker responses in which the participants were required to produce the names. In verbal behavior research, the incidental acquisition of the names as a selection response is termed the listener half of Naming and is differentiated from full Naming in which the participant acquires the name incidentally as both a speaker and a listener (Fiorile & Greer, 2007; Gilic, 2005; Greer, 2008; Greer & Keohane, 2005; Greer, Nirgudkar, & Park, 2003; Greer et al., 2005; Greer, Stolfi, & Pistoljevic, 2007; Helou-Care, 2008; Longano & Greer, in press; Pistoljevic, 2008). Childers and Tomasello found that the children were consistently able to produce the actions, but had few correct responses for the production of nouns and verbs. The participants demonstrated the actions associated with the object, but were unable to produce the name of the object or name of the action performed with the object. Interestingly, the researchers examined the number of exposures and number of sessions to acquire the nouns, verbs, and actions, and found that the children learned the actions regardless, while learning the nouns and verbs required multiple exposures over multiple sessions.

Consistently across these experiments, the researchers found that when adults and children were taught novel names and arbitrary actions for unfamiliar objects, all of the participants consistently acquired the actions before learning the object names. This raises the question of why acquisition of object actions precedes object names across developmental stages.
**Why object actions are learned before object names.** The acquisition of both actions and vocal language is a predominant topic of research across multiple fields with widely varied methodologies and theoretical approaches. The social science perspective documents observations of the acquisition of actions and names, and provides explanations based in theories of psychology and human evolution. Neuroscience also investigates the differences between learning actions and names, providing measurements of variations in brain activity. Research from both fields is discussed in this section, along with a possible synthesis of the findings.

**Social sciences.** Early in life, before the development of language and a functional imitative repertoire, humans learn about novel objects through direct experience. As adults, we are confronted with novel objects and learn not only the name, but also the function through observation (Hahn & Gershkoff-Stowe, 2010). Beyond the function, we must also learn the name of the object. Both are learned through similar mechanisms, in that the function can be learned through visual observation of the object’s use, and the name can be learned through auditory observation of others naming the object (Hahn & Gershkoff-Stowe, 2010). Although one stimulus is auditory and the other is visual, the researchers suggest that both are learned through “parallel processes that are tightly coordinated with perceptual and motor functions” (Hahn & Gershkoff-Stowe, 2010, p. 284).

Infants imitate the actions of others, initially as bodily movements and later as imitation of object manipulation (Meltzoff & Moore, 1977). Prior to the age of 2, children learn to imitate the actions of objects before they learn to produce the names of those objects as a speaker, and use demonstrations of the actions as a means of communication. The use of gestures precedes the use of vocal language, most likely because
developmentally, vocal communication is not yet an effective means of communication, while gestures obtain both attention and having one’s needs met (Acredolo & Goodwyn, 1988, 1993). In early development, infants emit vocalizations and actions simultaneously (Ejiri & Matasaka, 2001; Iverson & Fagan, 2004). Hahn and Gershkoff-Stowe (2010) suggest that early linguistic development is rooted in motor activity and there is a bidirectional relation between action and language, where “language informs action and action guides language” (p. 285).

At this point, it is apparent that actions are learned at a more rapid rate than names, indicating that names and actions are acquired differently. One possible evolutionary explanation for the rapid acquisition of actions is that an action that leaves no permanent product requires the individual to observe and learn immediately. But when the information remains in the environment, it can be readily accessed and eliminates the urgency for learning (Bloom, 2000). Experimentally, the non-verbal actions are demonstrated and then no longer available for viewing, so it is suggested that the child attended to the action and “fast mapped” the information (Childers & Tomasello, 2002). Fast mapping describes the use of the linguistic and non-linguistic context to determine the meaning of a word (Heilbeck & Markman, 1987). Once humans have observed the actions associated with the function of an object, when the object is presented in the future, the action becomes integrated as a feature of the object (Tomasello, 1999). Cognition theory asserts that objects and their names that have been previously paired with an action activate stored sensorimotor information regarding those actions.

In cognitive psychology, the association between objects and their functions is referred to as object-action mappings and those between the object and its name are termed
label-object mappings (Hahn & Gershkoff-Stowe, 2010). Much of the research in child development has approached acquisition of names and actions separately, but researchers are finding that object-word and object-action mappings can be treated as corresponding development (Hahn & Gershkoff-Stowe, 2010). Object-action mappings are retained over longer periods of time and are more likely to be produced by a young child, while object-word mappings are retained for shorter periods of time and are not easily produced. It is these contradictions that indicate that the acquisition of labels and actions may result from different routes of learning, despite both originating from sensorimotor processes (Hahn & Gershkoff-Stowe, 2010). The researchers suggest that actions are accessed more readily in memory than object names (Hahn & Gershkoff-Stowe, 2010). For example, when an object is presented visually, the action associated with that object is more readily accessible than its name. Producing the name requires the integration of semantic and phonological information (Riddoch & Humphreys, 1987; Yoon, Heinke, & Humphreys, 2002). It is the required lexical information that can impede the learning of names, in contrast to the visually-based learning of actions (Hahn & Gershkoff-Stowe, 2010).

**Neuroscience.** Embodiment Theory asserts that there is no distinction between cognitive processes such as perception and action and those of language and thought. Language processing and comprehension are tied to sensorimotor processing. In neuroscience, the theory underlines the connection and coordination of brain areas attributed to language and those for action (Jirak, et al., 2010). Citing neuroscience research, the embodied cognition perspective claims that the same sensorimotor areas are activated not only when interacting with the objects but also when hearing the names of those objects. Based on these findings, the brain areas related to action and language can
no longer be seen as independent but rather working in tandem. Broca's region is traditionally associated with language but has been recently found to be activated during grasping experiments, object manipulation, and object imitation (Binkofski et al., 1999; Grafton, Arbib, Fadiga, & Rizzolatti, 1996; Pulvermüller, 2005; Rizzolatti & Arbib, 1998). Actions performed by the individual, observed by the individual, and imagined by the individual have all been found to activate the corresponding sensorimotor areas of the brain (see Jirak et al., 2010).

Brain imaging has shown that observing a manipulable object activates areas of the brain related to object use and motor functions. When an individual reads words related to different body parts, brain imaging reveals that face, arm, and leg areas of the brain are activated based on the word read. In this case, the activation was not only reflective of the action word, but also the related area of the body (Hauk & Pulvermüller, 2004; Hauk, Johnsrude, & Pulvermüller, 2004). Similarly, when individuals are shown manipulable objects, brain activation in the areas that process actions was significantly greater than when presented with non-manipulable objects (Saccuman et al., 2003). Arevalo et al. (2007) compared aphasia patients with a control group, and found that the control group produced object names more readily for manipulable items as opposed to non-manipulable items. They hypothesize that the non-aphasic control participants use a processing strategy of motor imagery for manipulable objects while performing a task, which facilitates comprehension and naming.

Different object attributes such as the form and associated actions may be represented in multiple cortical areas. Using fMRI to examine neural responses in the areas of the brain associated with viewing and naming pictures, Chao and Martin (2000)
found that viewing and naming pictures of tools activated the left ventral premotor cortex. The activation of motor systems suggests a link between tools and the information about the associated actions.

Some neurons, described as Mirror Neurons (Gallese et al., 1996) discharge when an individual performs an action and also when observing an action, so it is theorized that the mirror neuron system is critical to forming motor memories and motor learning. Motor memory refers to a lasting change of local cortical movement representations as a result of repetition of physical movements, creating a physiological and observable change (Stefan et al., 2005). These motor memories are not only the product of direct action, but have also been found to occur when the individual observes the actions. Research with children ages 5-7 has produced somewhat conflicting results, in that when presented with objects, the motor systems were only activated when the children had actively interacted with the objects. For children, self-generated actions recruit motor regions more when compared to simply observing actions (Harman-James & Swain, 2011). The researchers expand upon the findings, hypothesizing that the discrepancy between the activation of motor systems during observation for adults and children can likely be attributed to the adult advantage of a cumulative history of experiences with words, objects, and actions.

The actions of objects are learned more readily than the production of their object names. Developments in neuroscience have shown that any object associated with an action immediately activates sensorimotor areas of the brain. Ruminati and Humphreys (1998) suggest that the neural retrieval path from object to action is more direct in comparison to that of the object to its name. In order to produce the name, semantic and phonological information must be activated and retrieved. On the other hand, the neural
areas associated with action are automatically activated upon observing the object (Hahn & Gershkoff-Stowe, 2010). It is likely that it is this immediate stimulus-response reaction that facilitates the acquisition of actions over names. This is not to say that the names cannot be acquired, only that the rate of acquisition differs in favor of actions. Hahn and Gershkoff-Stowe summarize the findings:

Label mappings appear to be fragile; relatively few object words can be learned at one time and those that are retained are generally accessible only in comprehension. Action mappings, in contrast, are considerably more robust: many actions can be learned at once and most support production as well as reception. (p. 303)

### Multiple Stimulus Control and Language

Multisensory perception refers to the co-occurrence of multiple stimuli, requiring “integration of the information” presented to the different senses. A significant body of research has been amassed on the topic, and the results show that multisensory interaction can either work to facilitate responses, or provide a sensory competition that hinders responses (Sinnett, Soto-Faraco, & Spence, 2008). Although it seems impossible that the presentation of multiple stimuli can be both beneficial and detrimental at the same time, Sinnett et al. suggest that the nature of the task may determine how the participant responds to multiple stimuli. The researchers found that when presented with bimodal stimuli (auditory and visual), the accuracy and rate of participant responses was affected by the complexity of the required response. In this case, bimodal stimuli improved participant performance when the response required was a “detection” response in which the participant pressed a single button when the stimuli were presented. On the other hand, when the response required was a “discrimination” response in which the participant had to
select among buttons to indicate which kind of stimulus was presented, the bimodal stimuli had a negative effect on performance. In the discrimination task, visual stimuli were dominant over auditory. In a second experiment, Sinnett et al. found that when presented with bimodal stimuli (auditory and visual) and a simple one-button detection task, participants responded more accurately and at a faster rate when identifying visual targets compared to auditory targets.

Although we respond to stimuli with multiple senses, it stands to reason that one sense may be dominant over another. The dominance of vision over the other senses has been consistently established experimentally. In a frequently cited experiment, Colavita (1974) reported that participants consistently attended to a visual stimulus, in this case an image, rather than an auditory stimulus when both were presented simultaneously. In fact some participants responded solely to the visual stimulus and were unaware that the auditory stimulus had occurred. This demonstration of the dominance of visual stimuli over auditory stimuli has since been referred to as the “Colavita effect”, and has been replicated in numerous experiments in the four decades since the initial publication of these findings (see Spence, 2009 for a summary). This body of research supports the “Colavita effect,” which refers to the dominance of visual stimuli, but also clarifies that task demands determine whether multisensory stimuli compete to hinder or are joined to facilitate responses. As discussed previously, observing responses to stimuli are established through a history of consequences, and the resulting stimulus control determines which stimuli will select out the individual’s attention. Research has established that the dominant and default sense for humans is visual, which ties into human phylogeny. The dominant human sensory modality of vision can interestingly be tied to
the arboreal nature of many other primates; hand-eye coordination and depth perception are critical to survival when swinging from tree-to-tree (Armstrong & Wilcox, 2007). In the case of multisensory stimuli, there is clearly a predisposition to attend to the visual aspects of a stimulus, but that alone does not determine how the individual will respond to the stimulus.

Beyond the experimental analysis of the relationship between visual and auditory stimuli in the research setting, these stimuli coexist naturally in our everyday use of language. Gestures while speaking are a common visual feature of human communication, and are typically used simultaneously with vocal speech to emphasize points or enhance meaning. Some research has established a symbiotic and beneficial relationship between iconic gesture and speech in which both act to facilitate comprehension. Iconic gesture refers to those gestures that convey meaning, such as putting a finger to one’s lips to indicate, “quiet.” Kelly, Ozyurek, and Maris (2010) found that pairing gestures with speech influenced speech comprehension, such that when gestures and speech convey the same information, comprehension and response rate are improved. But at the same time, researchers have found that iconic gestures can hinder acquisition of novel words and impede comprehension (Hirata & Kelly, 2010). How is it possible that the presence of gestures can both facilitate and hinder comprehension?

Singer and Goldin-Meadow (2005) analyzed different teaching methods for math in eight to ten year old children. The researchers compared combinations of gestural and verbal instruction for solving mathematical problems. They found that when verbal and gestural methods were used simultaneously, the children had more correct responses than either method in isolation. The critical piece of the instruction was that the verbal and
gestural methods conveyed different methods to solve the same problem, essentially different roads leading to the same location. Singer and Goldin-Meadow explain that the use of gesture in conjunction with verbal methods provides students with two approaches to problem solving. In this case, the presence of visual and auditory stimuli facilitated learning.

There are clearly multiple variables affecting the relationship between gesture and language. Kelly and Lee (2012) recently compared the acquisition of simple and complex Japanese word pairs taught simultaneously with iconic gestures for English speaking adults. The difficulty of the word pairs was based on the auditory similarity of the pair. In this case, the researchers determined that the participants acquired “easy” words when they were taught with gestures, while the presence of gesture inhibited the acquisition of the “hard” words. These findings mirror earlier research that found iconic gestures facilitate vocabulary acquisition in a second language when the phoneme constructions of the words are similar to the learner’s native language (Kelly, McDevitt, & Esch, 2009; Sueyoshi & Hardison, 2005). Kelly and Lee explain that when gesture is paired with more difficult words, it is possible that the added visual information interfered with the comprehension of the newly learned words. The researchers pose an explanation that adding iconic gestures to speech sounds creates a visual distractor that interferes with comprehension. It appears that in this case, it is the familiarity of the phonemic forms that determines whether the presence of gesture facilitates or hinders comprehension.

To use the term distraction creates an explanatory construct, which by its nature cannot be evaluated nor verified. By redefining “distraction” into measureable and testable variables, we can determine whether the phenomenon occurred and under which conditions.
Attention simply describes an observing response that is under the control of a stimulus, and that stimulus control has been established through a cumulative history of consequences. In these terms, distraction refers to an occasion in which multiple stimuli are present, but the individual’s observing responses are selected out by certain stimuli over others. Having redefined distraction, the experimenter can then present multiple stimuli to the participant, and systematically measure which of the stimuli select out his or her observing responses.

When contradictory visual and auditory stimuli are presented simultaneously, Choi (2012) found that the variations in responding were a function of observing responses shaped by instructional history. The researcher demonstrated an action (e.g., touching his nose) while giving a vocal direction (e.g., to jump), without specifying which of the two antecedent stimuli, visual or auditory, the participant should respond to. Also the researcher did not provide a consequence of reinforcement, and measured which of the two antecedent stimuli selected out the participant’s observing response. Prior to intervention, the participants overwhelmingly attended to the visual antecedent and imitated the experimenter’s actions without regard for the vocal directions. But following intensive auditory discrimination training, the vocal directions selected out participants’ observing responses and they responded to the directions without imitating the demonstrated actions. This experiment underscores the role of instructional history and reinforcement in observing responses. Establishing a history of reinforcement for auditory responses increases the likelihood that an individual will respond to an auditory stimulus. But it is interesting to note that the default observing response prior to intervention was visual, again supporting the “Colavita effect.”
**Indirect Acquisition of Language**

Having looked at the role of observation, imitation, and gesture in communication, one fundamental question remains: How do children acquire language? The acquisition of language has been a topic of discussion and subject of research across many years and many disciplines. Although there are multiple theories and dissenting voices, one clear and common theme is that the extensive vocabularies that children acquire cannot be attributed to direct instruction. Young children acquire a vast vocabulary at an incredibly rapid rate, characterized by a language “explosion” at around the age of three (Hart & Risley, 1995, 1999). It would be nearly impossible to directly teach each word that the child acquires. Research has found that children do not receive direct instruction for all of the language they acquire (Hart & Risley, 1995, 1999), so it becomes evident that the child must acquire language incidentally from his or her interactions with the environment.

**Verbal Behavior Developmental Theory.** Language acquisition begins long before the emergence of the first word. When outlining a theory of verbal development, Greer and Speckman (2009) describe the initial experiences during infancy that shape imitative human behavior, which subsequently affects the acquisition of verbal behavior. This is discussed in detail in the previous section titled “Imitation,” so only a brief overview will be provided here. Imitation emerges as the result of conditioned reinforcement in which established reinforcers are paired with imitative behavior. Once a sufficient cumulative history of pairing has been established, the imitative behavior itself becomes reinforcing such that the correspondence between observing and reproducing is in and of itself a reinforcing behavior (Greer & Speckman, 2009). This accounts for the
development of imitative physical behavior, which in turn sets the stage for the emergence of duplicative verbal behavior.

**Development of speaker behavior.** In the case of verbal behavior, the correspondence between what is heard and one’s own production is vastly different compared to the see-do imitative response. Speech can only be observed as an outcome because the process of speech production is obscured from the observer, but the correspondence is critical to the development of vocal verbal behavior (Greer & Speckman, 2009). In the emergence of speaker behavior, even before echoic behavior, children copy the vocal behavior of others, an act termed “parroting” by Skinner (1957). Parroting behavior entails the child hearing the correspondence between what he or she hears and subsequently produces. Imitation might not be the most accurate account of echoic behavior because the actual behavior cannot be observed, only the result can be observed aurally. Greer and Speckman suggest that emulation might be a more accurate term for echoic behavior.

For parroting behavior, the source of reinforcement is the correspondence between the sounds the infant hears, and his or her own production of those sounds. Although parroting is vocal, it is not verbal behavior because it produces no functional effects for the speaker mediated by the listener. But once the vocal sounds become paired with consequences, echoic behavior emerges (Greer & Speckman, 2009). After specific instances of echoic behavior are reinforced, generalized echoic behavior emerges in which the infant echoes novel vocal stimuli without reinforcement (Horne & Lowe, 1996). This echoic speaker behavior becomes integrated with listener behavior when the child is attending to a stimulus, hears the name of that stimulus and echoes it, which is then
socially reinforced (Horne & Lowe, 1996). Initially the echoic behavior is reinforced by others, but may later be automatically reinforced as a result of the numerous pairings between the echoic behavior and reinforcement (Skinner, 1957). At first the echoic behavior occurs in response to the speaker behavior of another person, rather than the object itself. But after repeated echoics in the presence of the stimulus, the object or event becomes the discriminative stimulus for the child’s speaker behavior (Horne & Lowe, 1996). Once the echoic behavior occurs in response to environmental stimuli, the behavior acquires function and then becomes truly verbal.

The presence of an echoic repertoire enables the individual to acquire and emit tacts, which in turn, creates more opportunities for social reinforcement (Pistoljevic & Greer, 2006). Tacts are vocal verbal operants that are under non-verbal control and are reinforced by a generalized reinforcer, such as attention (Skinner, 1957). The reinforcer for a tact is social attention, and a child who easily acquires and emits tacts will receive increased social attention. If that social attention functions as a reinforcer, then the child will increasingly emit tacts in the future. Acquiring tacts produces social reinforcement, which may establish a motivating operation to acquire new tacts.

**Development of listener behavior.** Before children learn to speak, they learn to listen, and listener behavior is a critical prerequisite for linguistic behavior (Horne & Lowe, 1996). Listener behavior occurs when correspondence is established between a vocal stimulus produced by a speaker and the behavior of a listener. The child must first discriminate speech sounds from non-speech sounds (Horne & Lowe, 1996), which in Verbal Behavior Developmental Theory is described as the speaker behavior of others becoming a conditioned reinforcer for observing behavior (Greer & Ross, 2008; Greer &
Speckman, 2009). Once voices become a discriminative stimulus for attending, joint attention emerges between the caregiver and child to an object or event paired with its name. The caregiver reinforces behaviors such as pointing to objects or events and responding as a listener to verbal stimuli (Horne & Lowe, 1996). Echoic speaker behavior then becomes integrated with listener behavior when the child is attending to a stimulus, hears the name of that stimulus and echoes it, which is then socially reinforced (Horne & Lowe, 1996). It is the joining of the listener and speaker repertoires that establishes the capability for incidental language acquisition.

**Speaker as own listener: Naming.** An accumulation of research on the indirect acquisition of language has contributed to the discovery of a capability referred to as Naming. It should be noted that the capitalized “Naming” is used to differentiate the higher order verbal operant that is a developmental cusp and capability from the common usage of the word “naming” (Greer, 2008; Greer & Ross, 2008; Greer & Speckman, 2009). Naming describes the phenomenon by which an individual simply hears a word or phrase and can then produce the word or phrase as a speaker at a later time. Greer and Ross (2008) describe the Naming experience, in which the individual visually observes a stimulus while hearing its name. A typical Naming experience could occur when, for example, a mother points to a brightly colored bird, says “Look, it’s a parrot!” while her child looks at the aforementioned bird. In this example, the child visually observed the stimulus and hears its name. If the child has the developmental capability of Naming, then he or she will later identify similar birds as parrots. Naming allows an individual to hear something as a listener and later produce that response as a speaker or learn something as a speaker and later respond to it as a listener without direct instruction. The presence of a
Naming repertoire allows the rate of learning to increase exponentially because learning can occur outside of the instructional setting and no longer requires direct instruction (Greer, 2008; Greer & Keohane, 2005; Greer & Speckman, 2009). Once a child acquires this capability, he or she can learn through incidental exposure (Fiorile & Greer, 2007; Gilic, 2005; Greer, 2008; Greer & Keohane, 2005; Greer, Nirgudkar, & Park, 2003; Greer et al., 2005; Greer et al., 2007; Helou-Care, 2008; Longano & Greer, in press; Pistoljevic, 2008). Naming could account for the seemingly “innate” acquisition of language described by linguists, in that a child with a Naming repertoire learns language without direct instruction or reinforcement (Greer & Longano, 2010). Observation alone can result in the acquisition of both speaker and listener responses.

**Multiple Exemplar Instruction and Naming**

Lowenkron (1997) proposed that the joining of the speaker and listener behavior was a function of an instructional history of differential reinforcement for multiple exemplar experiences. Joint control, in which one stimulus controls multiple responses, resulted from a history of multiple exemplar experiences (Lowenkron, 1998). A growing body of research has found that multiple exemplar instruction across listener and speaker responses results in the emergence of untaught responses for novel stimuli, which is considered essential for the acquisition of Naming (Fiorile, 2005; Fiorile & Greer, 2007; Gilic; 2005; Greer, et al., 2003; Greer et al., 2005; Greer et al., 2007; Helou-Care, 2008; Longano & Greer, in press; Pistoljevic, 2008). Multiple exemplar instruction (MEI) provides a history of reinforcement for responding to the same stimuli with multiple responses (Greer & Longano, 2010). Several experiments have determined that the Naming repertoire, which requires the joining of the listener and speaker behavior, can be
induced through MEI for children with developmental delays (Fiorile, 2005; Fiorile & Greer, 2007; Greer, Nirgudkar, & Park, 2003; Greer, Stolfi, Chavez-Brown, & Rivera-Valdes, 2005; Greer, Stolfi, & Pistoljevic, 2007; Helou-Care, 2008; Longano & Greer, in press; Pistoljevic, 2008) and typically developing 2 year-old children who had not yet acquired Naming (Gilic, 2005). Across all of these experiments, the researchers established that the participants did not have the Naming repertoire and subsequently implemented MEI in which multiple responses to a single stimulus (match-to-sample, point-to, tact, and intraverbal responses) were rapidly rotated across stimuli. Following the intervention, the participants could produce untaught speaker and listener responses to novel stimuli after only hearing the tact for the stimuli during match-to-sample instruction.

The critical component of inducing the Naming repertoire is MEI; learning the same multiple response topographies separately does not result in the acquisition of Naming (Greer et al., 2007). The reinforcement of a subset of stimulus-response-consequence relations for both speaker and listener responses leads to the joining of both in a common class (Greer & Longano, 2010). For typically developing children, it is likely that naturally occurring multiple exemplar experiences are sufficient for the acquisition of Naming as a result of their prior environmental experiences and neural capabilities (Gilic, 2005).

**MEI, Naming, and Other Repertoires**

Recent research has extended the theory of Naming, by demonstrating its importance in the acquisition of other academic skills (Corwin & Greer, in press; Greer, Corwin, & Buttigieg, 2010; Helou-Care, 2008; Reilly-Lawson, 2008). In each of these studies, the presence of Naming facilitated acquisition of academic skills, such as reading
comprehension (Helou-Care, 2008), reading and writing (Reilly-Lawson, 2008), and learning from Model-Demonstration Learn Units in mathematics (Corwin & Greer, in press; Greer et al., 2010). Research has also evaluated the common teaching practice of modeling, initially for students who lacked the capability for Naming, and later after they had acquired the capability (Corwin & Greer, in press; Greer et al., 2010). They found that prior to the presence of the capability of Naming, the participants benefitted minimally from a teacher model, measured as the acquisition of instructional objectives. Following the induction of Naming, these same students demonstrated a sharp increase in their rate of learning when instructed with a teacher model. The results indicate that the Naming capability allowed the participants to accelerate their learning of academic skills through observation of a teacher model. More importantly, the children without a Naming capability did not benefit from the teacher model, indicating that Naming functions as a prerequisite for learning from the traditional teaching method of demonstration. Much of the initial research on Naming explored the capability in reference to the acquisition of language, and this experiment extends the findings more generally to the necessity of Naming to facilitate student learning through observation.

Prior to the induction of Naming, the students lacked the capability to join seeing, as in the teacher model, with doing, by producing correct responses to the math problems. Earlier research established that one of the procedures to induce Naming, MEI, results in the joining of the listener and speaker repertoires, such that learning one form results in the emergence of the other. Researchers have also found that the students joined an observing and a production response as a result of MEI to induce Naming (Corwin & Greer, in press;
Greer et al., 2010). It becomes clear that MEI is critical not only to the acquisition of Naming, but also has profound effects on other areas of learning beyond language.

**Summary and Rationale**

Similar to the theories of language acquisition, it is unlikely that children learn only from direct instruction. Rather, it would seem that children also learn indirectly from what they hear and see, and these individual experiences join to form emergent relations beyond basic language acquisition. As a result of exposure to MEI in previous research, the students acquired the ability to join previously independent repertoires. Based on research findings that students who acquire the capability for Naming can learn from experience, or observation, I propose it is also likely that they can acquire multiple responses, in addition to the listener and speaker, from one experience. For example, if a student observes the manipulation of an object while hearing the teacher say the name of the object, does the student learn the name of the object as both a listener and speaker? Do they learn to imitate the action demonstrated with the object? Can they join the name to the demonstration of the action? And finally, when presented with multiple stimuli what aspects select out an observing response?
CHAPTER II: EXPERIMENT I

Method

Participants

The participants in this study were 16 preschool students ranging in age from 3.1 to 5.0 years old, with a mean age of 4.2. Thirteen of the participants were diagnosed as preschoolers with a disability, and three were typically developing. All of the participants were speakers and listeners. These participants were selected based on their verbal behavior developmental cusps and capabilities, with each participant having the prerequisite repertoires of generalized imitation, generalized matching, tacts, and the listener component of Naming. The presence or absence of these repertoires was established through administration of the criterion referenced CABAS International Curriculum and Inventory of Repertoires for Children from Pre-School through Kindergarten, which is referred to as the C-PIRK (Greer & McCorkle, 2009; Waddington & Reed, 2009) as well as the Verbal Behavior Developmental Assessment (Greer & Ross, 2008). The participant characteristics are summarized in Table 1.

The participants were recruited from a publicly funded private preschool, serving students with and without disabilities from ages 16 mos to 5 yrs old. The participants were recruited from classrooms that included both typically developing students and students with disabilities. In the preschool, the students were assigned to classrooms based on their verbal developmental cusps and capabilities rather than based on chronological age or normative referenced test scores. School wide, the teachers applied the instructional tactics of behavior analysis and verbal behavior to measurably advance student cusps and capabilities.
<table>
<thead>
<tr>
<th>Age</th>
<th>Gender</th>
<th>IEP</th>
<th>Listener</th>
<th>Speaker</th>
<th>Generalized Matching</th>
<th>Generalized Imitation</th>
<th>Listener Half of Naming</th>
<th>Full Naming</th>
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</tbody>
</table>
Setting and Materials

All sessions were conducted in a nearby classroom at a time when no other students were present to minimize distractions from competing stimuli. The sessions took place at a child-sized table with the participant seated in a child-sized chair. The experimenter was seated directly across from the participant so that the experimenter’s movements were easily viewed throughout the session.

The materials used for both the dependent and independent variables consisted of sets of three novel target objects. Two identical exemplars of each target stimulus were included in the set. The target stimuli were three-dimensional objects, selected from unfamiliar tools, hardware items, household objects, and kitchen utensils. The objects were assigned a contrived name and grouped into sets of three stimuli. Actions were assigned to the sets, and were rotated within the sets across participants. The novel labels and nonverbal actions are listed in the Appendix.

For each of the eighteen objects, a name was selected from a list of eighteen names. Assignment of names to the objects was done by using a non-repeating random number generator (1-18) and matching the corresponding numbers between the names and objects. The objects were then grouped into sets of three, again using the non-repeating random number generator, creating a total of six sets. Actions were assigned to the sets, rather than the objects, such that the actions paired with stimuli were interchangeable within each set.

Twelve of the novel labels and nonverbal actions are a direct replication of those used by Hahn and Gershkoff-Stowe (2010). These contrived names were one or two syllables and were based on the sounds in early language development (Sander, 1972; Stoel-Gammon, 1985). Each stimulus was randomly assigned an action, such that any
action could be performed with any object. In order to eliminate the possibility that the participant could infer the action based on the form of the objects, the actions were arbitrarily assigned and not dictated by the structure of the object. The use of interchangeable arbitrary names and actions is based on the experimental procedures of Hahn and Gershkoff-Stowe. To create additional sets, six novel names were created using one to two syllables and were based on early language development sounds, similar to those developed by Hahn and Gershkoff-Stowe. Six additional actions were created, such that the objects would be manipulated on the table or directly above the table in view of the participant.

All of the six sets were varied across the participants. To ensure that the stimuli were not familiar in either name or function to the participants, pre-experimental probe trials were conducted to determine if the name or actions associated with the stimuli were in the participant’s repertoire. Stimuli that were known to any participant in either name or function were removed from the sets prior to the experiment.
Appendix

List of Stimuli Sets with Objects, Names, and Actions

<table>
<thead>
<tr>
<th>Set #</th>
<th>Names</th>
<th>Objects</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Bek</td>
<td>Cookie cutter</td>
<td>With one hand, swoop object through air in circles</td>
</tr>
<tr>
<td></td>
<td>Tata</td>
<td>Dog toy</td>
<td>With object on table, tap with one hand</td>
</tr>
<tr>
<td></td>
<td>Peeb</td>
<td>Wood tone block</td>
<td>Make object jump vertically</td>
</tr>
<tr>
<td></td>
<td>Mup</td>
<td>Napkin ring</td>
<td>Hold object in front of mouth and blow on it</td>
</tr>
<tr>
<td>2</td>
<td>Tam</td>
<td>Strainer</td>
<td>Place object on head</td>
</tr>
<tr>
<td></td>
<td>Pimmel</td>
<td>Silicone poacher</td>
<td>Bat object back and forth between two hands</td>
</tr>
<tr>
<td>3</td>
<td>Deet</td>
<td>Drink clip</td>
<td>Touch object to nose</td>
</tr>
<tr>
<td></td>
<td>Mig</td>
<td>Wood spinner</td>
<td>Walk object forward and back on table</td>
</tr>
<tr>
<td></td>
<td>Ibby</td>
<td>Loofah</td>
<td>Rotate object in air using two hands</td>
</tr>
<tr>
<td></td>
<td>Ziz</td>
<td>Strainer</td>
<td>Touch object to table</td>
</tr>
<tr>
<td>4</td>
<td>Lupa</td>
<td>Note holder</td>
<td>Hide object behind back</td>
</tr>
<tr>
<td></td>
<td>Dop</td>
<td>Jar opener</td>
<td>Rub on stomach</td>
</tr>
<tr>
<td></td>
<td>Tay</td>
<td>Juicer</td>
<td>Roll between hands</td>
</tr>
<tr>
<td>5</td>
<td>Niff</td>
<td>Thimble</td>
<td>Drive on table top in a figure 8</td>
</tr>
<tr>
<td></td>
<td>Gugi</td>
<td>Brillo</td>
<td>Slide on arm from hand to shoulder</td>
</tr>
<tr>
<td>6</td>
<td>Dow</td>
<td>Reusable ice cubes</td>
<td>Hold against ear</td>
</tr>
<tr>
<td></td>
<td>Oot</td>
<td>Tube roller</td>
<td>Balance on palm with arm extended</td>
</tr>
<tr>
<td></td>
<td>Booma</td>
<td>Wheels</td>
<td>Move horizontally in air back and forth</td>
</tr>
</tbody>
</table>

Note. Stimuli sets consist of contrived names, actual objects, and actions. Each object is assigned a specific name, while the actions associated with the objects are rotated and counterbalanced across participants. These sets of stimuli were used for all of the three experiments.
Design

Each participant received two sessions of the Naming experience, which consisted of match to sample instruction while hearing the experimenter tact the stimulus with demonstration of actions. This was followed by measures of the dependent variable, which was comprised of correct responses to probe trials for untaught responses. Responses to probe trials were measured for action selection, action demonstration, and the untaught listener and speaker responses to the stimuli.

The results were analyzed using a repeated measure ANOVA with two within subject factors: Condition (Action, Name) and Test (Receptive, Productive). The Action Condition was comprised of action demonstration and action selection, and the Name Condition included listener and speaker responses to the stimuli. The Receptive Test consisted of correct responses to the selection trials for action selection and listener responses, while the Productive Test was measured as the number of correct response for action demonstration and speaker responses to the stimuli. These individual responses collectively comprised the dependent variable of correct responses to probe trials.

Procedure

Experimenter antecedents and target participant responses are summarized in Table 2.
## Table 2

### Antecedents and Responses for Experiment I

<table>
<thead>
<tr>
<th>Response</th>
<th>Experimenter Antecedent</th>
<th>Target Participant Response</th>
</tr>
</thead>
<tbody>
<tr>
<td>Naming Experience</td>
<td>Match to sample</td>
<td>Selects identical visual version of stimulus from field of 3 stimuli</td>
</tr>
<tr>
<td>Dependent Measures</td>
<td>Action Selection</td>
<td>Selects stimulus associated with the demonstrated action from field of 3 stimuli</td>
</tr>
<tr>
<td>Action Demonstration</td>
<td>Gives participant the stimulus and asks, “Show me what this does.”</td>
<td>Demonstrates action associated with stimulus</td>
</tr>
<tr>
<td>Listener</td>
<td>Asks, “Find ___.”</td>
<td>Selects named stimulus from field of 3 stimuli</td>
</tr>
<tr>
<td>Speaker</td>
<td>Presents stimulus and asks, “What is this?”</td>
<td>Names stimulus</td>
</tr>
</tbody>
</table>

Note: For all responses, one exemplar of each of the three target stimuli in the set were arranged on the table in front of the participant.
**Naming experience: Match to sample with demonstration of function.** During the Naming experience, each participant received learn units for matching by selecting identical visual versions of each target stimulus while hearing the experimenter tact the name of the stimulus and simultaneously demonstrating its function. Match instruction was presented as learn units, a measure of instruction, which predicts student learning (Albers & Greer, 1991; Greer, 1994; Greer, 2002). The learn unit consists of one potential three term contingency for the student and two or more three term contingencies for the teacher (Albers & Greer). In this case, the learn unit consisted of the experimenter obtaining the participant’s attention, presenting the antecedent, and consequating the participant’s response. Although the response topography consisted of visual matching, the critical component of the Naming experience for the participant was hearing the experimenter tact the name of the stimulus while visually attending to it. The match to sample instruction functioned as a context for joint attention in which the participant observed both visual and auditory aspects of the stimulus. Inclusion of the match to sample response topography ensured that the participant visually attended to the stimulus by requiring the selection response. The Naming experience experimentally creates an opportunity for incidental language acquisition.

The experimenter placed one exemplar of each stimulus in the set on the table in front of the participant. The learn unit consisted of the experimenter obtaining the participant’s attention, while demonstrating the function of an identical visual version of one of the target stimuli, and presenting the antecedent “Find ______.” Because the response topography was not specified in the antecedent, correct responses were recorded if the participant pointed to or picked up the stimulus from the field. The antecedent was
intentionally non-specific, such that the participant’s response did not require a
demonstration of action but allowed he or she to pick up the stimulus and manipulate it.
An antecedent that specified the topography of the selection response, such as “Point to”
would eliminate the possibility of object manipulation. A correct response for the
participant was recorded if he or she selected the identical stimulus from the field of three
stimuli. The experimenter provided reinforcement in the form of praise and tokens
contingent on correct responses. An incorrect response was recorded if he or she selected a
stimulus different from the one presented by the experimenter. In the case of an incorrect
response, the experimenter delivered a correction procedure in which the antecedent was
re-presented and the correct response was prompted. Data were collected for the number
of correct and incorrect responses to learn units for match instruction.

Criterion for mastery of the match instruction was two consecutive sessions with
100% accuracy. One session of match instruction consisted of six match learn units for
each of the three stimuli, with a total of 18 learn units per session. It has been consistently
found across human and animal learning research that multiple exposures distributed
across multiple sessions are optimal when compared to an equal number of exposures in a
singular session (Childers & Tomasello, 2002; Dempster, 1996). Childers and Tomasello
found that distributed sessions across multiple days resulted in increased acquisition of
nouns and verbs when compared to massed sessions within a single day. One daily
exposure across 4 days resulted in increased correct production responses while eight
exposures in a single day did not. Sessions for this experiment were presented across
consecutive days, with no more than one session of match to sample instruction presented
per day.
Dependent variable. The dependent variable was correct responses to probe trials. These responses were measured for selection of objects associated with actions, demonstration of actions, listener, and speaker responses. The action selection and listener responses were categorized as receptive, while the action demonstration and speaker responses were productive.

Probe trials for selection of objects associated with actions. Following mastery of match to sample instruction in the Naming experience, the experimenter allowed a minimum of one hour and maximum of two hours to elapse and presented unconsequated probe trials for selection of objects associated with actions. The experimenter placed one exemplar of each stimulus in front of the participant. The experimenter then demonstrated one of the actions associated with a stimulus, but without using the stimulus and only demonstrating the action while asking, “Which one does this?” A correct response was recorded if the participant selected the stimulus that performed the action demonstrated by the experimenter. If the participant selected any other stimulus or no stimulus, an incorrect response was recorded. No consequences were provided for any probe trials. Two probe trials were presented for each of the stimuli for a total of six unconsequated probe trials.

Probe trials for demonstration of actions. Next, the experimenter presented unconsequated probe trials for demonstration of actions with the stimuli. The experimenter presented the participant with each stimulus, one at a time, with the antecedent, “Show me what you do with this.” A correct response was recorded if the participant accurately duplicated the actions demonstrated during the pre-experimental match instruction. An incorrect response was recorded if the participant produced another action or no action. No consequences were given for any of the responses to the probe
trials. Two probe trials were delivered for the action imitation for each target stimulus, for a total of six trials.

**Probe trials for listener responses.** Following the action probe trials, the experimenter then presented unconsequated probe trials for acquisition of the names of the target stimuli as a listener. Using the same set of stimuli from the match instruction, the experimenter placed one exemplar of each stimulus on the table in front of the participant, and delivered probe trials for listener responses to the target stimuli. The antecedent was delivered as “Give me a ____.” Two probe trials were delivered for the listener response to each target stimulus, for a total of six trials. The trials were rotated such that the same target stimulus was not selected for two consecutive probe trials. A correct response was recorded if the participant selected the named stimulus, and an incorrect response was recorded if the participant selected a different stimulus or did not respond. Correct and incorrect responses were recorded, and no reinforcement or correction was given following any trial.

**Probe trials for speaker responses.** Next, the experimenter presented probe trials for the intraverbal speaker responses to the target stimuli. For the intraverbal response, the experimenter obtained the participant’s attention, the experimenter held up one target stimulus and asked, “What is this?” A correct response consisted of the participant producing the name of the stimulus presented. Two probe trials were delivered for the intraverbal response to each target stimulus, for a total of six trials. The trials were rotated such that the same target stimulus was not presented for two consecutive probe trials. Correct and incorrect responses were recorded, and no reinforcement or correction was given following any trial.
Interobserver Agreement and Procedural Fidelity

Interobserver agreement (IOA) was collected for match instruction during the Naming experience, probe trials for Naming, actions, and joining an action to an object name. Data for IOA were collected by a trained observer either simultaneously recording data during the session or reviewing video of the session and recording data. The percentage of IOA was calculated by dividing the number of agreements by the total number of agreements plus disagreements and multiplying by 100%.

In addition, the Teacher Performance Rate Accuracy (TPRA) (Ingham & Greer, 1992) was used to ensure procedural fidelity. In this case, the TPRA was used to determine that learn units were in place during the match instruction and that the unconsequated probe trials were conducted accurately and consistently across experimenters. IOA was calculated for 38% of the match to sample instruction, with 100% agreement, and for 69% of the measures of the dependent variables, with 99% agreement.
Results and Discussion

The dependent measure of correct responses to probe trials was analyzed using a repeated measures ANOVA. Two within subject factors were analyzed: Condition (Name, Action) and Test (Receptive, Productive). These results are summarized in Figure 1. The main effect of Condition (Name, Action) was significant, F (1, 15) = 24.61, p < .001. The results show that the participants acquired all of the actions (M=6.00, SD=0.0), but fewer names (M=4.78, SE=.25). The main effects of Test (Receptive, Productive) F (1, 15) = 20.35, p < .001 was significant. The participants had more correct receptive responses (M=5.94, SE=.04) in comparison to the productive responses (M=4.84, SE=.24). For the interaction between Condition and Test, the interaction was significant F (1, 15) = 20.35, p < .001. The participants acquired the names as a receptive response (M=5.88, SD=.34) more readily in comparison to the names as a productive response (M=3.69, SD=1.92). No difference was found between the receptive and productive responses to the actions, with the same results for both responses (M=6.00, SD=.0).
<table>
<thead>
<tr>
<th></th>
<th>Mean</th>
<th>Standard Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Name Receptive (Listener)</td>
<td>5.88</td>
<td>.34</td>
</tr>
<tr>
<td>Name Productive (Speaker)</td>
<td>3.69</td>
<td>1.92</td>
</tr>
<tr>
<td>Action Receptive (Selection)</td>
<td>6.00</td>
<td>.00</td>
</tr>
<tr>
<td>Action Productive (Demonstration)</td>
<td>6.00</td>
<td>.00</td>
</tr>
</tbody>
</table>

*Figure 1.* Responses to Condition (Action, Name) and Test (Receptive, Productive)
Across all of the participants, the actions associated with the objects were readily acquired, as both a selection and production response. Consistent with the findings of Hahn and Gershkoff-Stowe (2010), the actions selected out the observing responses of these participants. In this case, the stimulus control was exerted by the action of the objects rather than the names. The stimuli consisted of the physical object, its actions, and its name. All of these aspects were available, but particular aspects of the stimulus selected out the observing responses of the individual participants.

All of the participants selected and produced actions with 100% accuracy, indicating that actions select out attention. At the same time, the participants consistently acquired the names for the stimuli as a listener with 98% accuracy. The names of the objects selected out the observing responses of the participants, as indicated by the correct responses to the listener or selection probe trials. Given the name of an object, the participants were able to select the corresponding object from a field. But, this did not extend to the speaker response. In fact, it is clear that a sharp distinction exists between the listener and speaker responses to the stimuli. The participants were able to easily select the correct object when it was named by the experimenter, but had difficulty when asked to independently produce the name of an object, responding with 61% accuracy. There is a vast distance between the listener and speaker responses, and the two repertoires develop independent of each other. In reference to the present research, after the Naming experience, these participants acquired the names of the stimuli as a listener. The concurrent lack of speaker responses indicates that the speaker and listener repertoires exist separate from one another. When these repertoires join, one becomes capable of incidental language acquisition. Simply hearing a word results in both listener and speaker responses.
This is the Naming capability, which represents a giant leap forward developmentally for language acquisition.

When viewed in reference to the Naming repertoire, the present research raises questions about the relationship between observing responses and the corresponding stimulus control of objects, names, and actions in language acquisition. If the participants were provided with Naming experiences for the same sets of stimuli, without the presence of actions, would the responses differ significantly when compared to those presented with actions? Will the participants readily acquire the names of objects as a speaker without the presence of actions in the Naming experience? One of the primary benefits of single-case design is that the results provide an opportunity to view individual differences and variations that are not apparent in a group design. Since the question of interest focuses on the responses of the same individual to differing stimulus conditions, a single subject design with alternating conditions within each participant was used for the Experiment II. In this way, it is possible to measure individual responses to the stimuli with and without the presence of actions.
CHAPTER III: EXPERIMENT II

Method

Participants

The participants in this study were seven preschool students ranging in age from 3.10 to 5.5 years old. Three of the participants were diagnosed as preschoolers with a disability, and four were typically developing. All of the participants were speakers, listeners, and emergent reader-writers. These participants were selected based on their verbal behavior developmental cusps and capabilities, with each participant having the prerequisite repertoires of generalized imitation, generalized matching, tacts, and the listener component of Naming. The presence or absence of these repertoires was established through administration of the criterion referenced *CABAS International Curriculum and Inventory of Repertoires for Children from Pre-School through Kindergarten*, which is referred to as the C-PIRK (Greer & McCorkle, 2009; Waddington & Reed, 2009) as well as the *Verbal Behavior Developmental Assessment* (Greer & Ross, 2008). The participants were recruited from the same setting as described in Experiment I. A description of the participants is presented in Table 3.
Table 3

*Participant Characteristics for Experiment II*

<table>
<thead>
<tr>
<th>Participant</th>
<th>Gender/ Age</th>
<th>Verbal Capabilities</th>
<th>Individualized Education Plan (IEP)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1a</td>
<td>Female/ 5.0</td>
<td>Generalized imitation Speaker Listener Listener half of Naming Conversational units</td>
<td>No IEP</td>
</tr>
<tr>
<td>1b</td>
<td>Female/ 3.9</td>
<td>Generalized imitation Speaker Listener Listener half of Naming Conversational units</td>
<td>No IEP</td>
</tr>
<tr>
<td>2a</td>
<td>Female/ 5.0</td>
<td>Generalized imitation Speaker as own listener Full Naming Conversational units</td>
<td>Preschooler with a Disability</td>
</tr>
<tr>
<td>2b</td>
<td>Male/ 5.5</td>
<td>Generalized imitation Speaker as own listener Full Naming Conversational units</td>
<td>Preschooler with a Disability</td>
</tr>
<tr>
<td>3a</td>
<td>Female/ 5.0</td>
<td>Generalized imitation Speaker as own listener Full Naming Conversational units</td>
<td>No IEP</td>
</tr>
<tr>
<td>3b</td>
<td>Female/ 4.3</td>
<td>Generalized imitation Speaker as own listener Full Naming Conversational units Naming by exclusion</td>
<td>No IEP</td>
</tr>
<tr>
<td>4b</td>
<td>Female/ 3.10</td>
<td>Generalized imitation Speaker as own listener Naming Conversational units Naming by exclusion</td>
<td>Preschooler with a Disability</td>
</tr>
</tbody>
</table>
Setting and materials

The setting and materials used were identical to those in Experiment I.

Design

For each participant, experimental action conditions and no-action control conditions were alternated for a total of six phases. Participant responses under the two conditions were compared using single case experimental design with alternating treatments counterbalanced across matched pairs. Single case design minimizes intersubject variability, while alternating the conditions allows the experimenter to evaluate the effects within the responses of the same participant (Barlow & Hayes, 1979; Barlow & Hershen, 1973; Browning, 1967; Sidman, 1960). Each participant completed six phases, with the phases alternated in a counterbalanced fashion across participants (e.g., ABABAB or BABABA).

Participants were paired based on capabilities and levels of verbal behavior. Within each pair, the participants were assigned to begin with either the no action control or action experimental condition. It should be noted that Participant 4a was unable to complete the experiment due to absences, and is not included in the results. The conditions were counterbalanced such that one participant in the pair received the no action condition for a set and the paired participant received the action condition for the same set. The sequencing of the sets was counterbalanced across pairs. The sequencing of conditions and sets are listed in Table 4.
Table 4

*Counterbalanced Sequencing of Sets for Experiment II*

<table>
<thead>
<tr>
<th>Participant</th>
<th>Sequence of Sets and Conditions</th>
</tr>
</thead>
<tbody>
<tr>
<td>1a</td>
<td>1 2 3 4 5 6</td>
</tr>
<tr>
<td>1b</td>
<td>1 2 3 4 5 6</td>
</tr>
<tr>
<td>2a</td>
<td>2 3 5 1 6 4</td>
</tr>
<tr>
<td>2b</td>
<td>2 3 5 1 6 4</td>
</tr>
<tr>
<td>3a</td>
<td>3 4 2 6 1 5</td>
</tr>
<tr>
<td>3b</td>
<td>3 4 2 6 1 5</td>
</tr>
<tr>
<td>4b</td>
<td>5 6 1 2 4 3</td>
</tr>
</tbody>
</table>

A = Action Condition

B = No Action Condition
In the no action condition, the student received two sessions of the Naming experience, with match to sample instruction while hearing the experimenter tact the stimulus, followed by probe trials for untaught listener and speaker responses to the stimuli. In the action condition, the student also received two sessions of the Naming experience, with the addition of demonstration of actions during the match to sample instruction. This was followed by probe trials for actions, untaught listener and speaker responses to the stimuli, and joining of the listener response with action imitation.

**Procedure**

All of the experimenter antecedents and participant response topographies are outlined in Table 5.

**Action condition: Naming experience with match to sample and demonstration of function.** The Naming experience for the action condition was identical to Experiment I. Participants received two sessions of match to sample instruction while hearing the experimenter tact the name of the stimulus and simultaneously demonstrating its actions. The mastery criterion remained at 100% across two consecutive sessions.

**Action condition: Dependent variables.** The seven dependent measures included probe trials for demonstration of actions, listener responses, and intraverbal responses, which were identical to Experiment I. The action selection response was omitted, due to the redundancy of the responses for action selection and action demonstration in Experiment I. In addition to the previously listed dependent variables, measures for echoics and actions emitted during the Naming experience were included as dependent measures. Additional probe trials were included for tact responses to the stimuli as well as measures for joining an action to the object name, which are described as follows.
Echoics emitted during the Naming experience. Throughout the match to sample instruction, the experimenter recorded whether the participant emitted echoics at any point during the learn unit. Echoics were not a response requirement, rather the experimenter recorded if echoic behavior occurred. Echoics were not conseuated during match to sample instruction. The number of echoics emitted was recorded as the number of occurrences out of the total number of echoic opportunities, which in this case was the total number of match to sample learn units presented.

Action demonstration imitation during the Naming experience. During match to sample instruction, the experimenter recorded whether the participant imitated the actions demonstrated with the objects. The required response during match instruction was the selection of the identical visual version of the stimulus presented by the experimenter. Action demonstration was not a required response and therefore was not corrected or reinforced. The experimenter recorded whether the participant imitated the action demonstration at any point during the instruction. The number of actions demonstrated was recorded as the number of occurrences out of the total number of action opportunities, which in this case was the total number of match to sample learn units presented.

Probe trials for tact responses to the stimuli. Following the probe trials for the listener responses to the stimuli, the experimenter presented probe trials for the tact (speaker responses) to the target stimuli. For the tact response, the experimenter obtained the participant’s attention, and held up one target stimulus without any verbal antecedent. The target tact response consisted of the participant independently producing the name of the presented stimulus. Two probe trials were delivered for the tact response to each target stimulus, for a total of six trials. The trials were rotated such that the same target stimulus
was not presented for two consecutive probe trials. Correct and incorrect responses were recorded, and no reinforcement or correction was given following any trial.

**Probe trials for joining actions object names.** After completing the probe trials for Naming, the experimenter used the same set of stimuli to conduct additional probe trials for the joining of the listener response to the demonstrated function of the object. Again the experimenter placed one of each target stimulus on the table in front of the participant, and presented the antecedent, “Show me what a ______ does.” A correct participant response consisted of selecting the named stimulus, and demonstrating the function of the stimulus. An incorrect response consisted of selecting a stimulus different from the one named, or demonstrating a different function for the stimulus named.

Two probe trials were delivered for joining the action to the object name for each target stimulus, with a total of six trials. The trials were rotated such that the same target stimulus was not selected for two consecutive probe trials. Correct and incorrect responses were recorded, and no reinforcement or correction was given following any trial.

**No action condition: Naming experience with match to sample.** During the Naming experience, each participant received learn units for match to sample responses for identical visual versions of each target stimulus while hearing the experimenter tact the name of the stimulus. No actions were presented in this condition. The experimenter placed one of each target stimulus on the table in front of the participant. The learn unit consisted of the experimenter obtaining the participant’s attention, holding up an identical visual version of the target stimulus, and presenting the antecedent “Find ______.” In the no action condition, the responses were recorded and consequted identical to those in the action condition described in Experiment I.
No action condition: Dependent variables. There were four dependent measures, which were identical to those in the action condition, with probe trials presented for listener responses, speaker responses, and measures for echoics emitted during the Naming experience. Since there were no actions associated with the stimuli in this condition, the measures for action demonstration, joining an action to an object name, and occurrences of actions during the Naming experience were not included.

Interobserver Agreement and Procedural Fidelity

The methods for collecting and calculating interobserver agreement (IOA) for the Naming experience and measures of the dependent variables were identical to those used in Experiment I. Table 6 summarizes IOA and procedural fidelity for Experiment II.
Table 5

Antecedents and Responses for Action and No Action Conditions

<table>
<thead>
<tr>
<th>Response</th>
<th>Experimenter Antecedent</th>
<th>Target Participant Response</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Action Condition:</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Naming Experience</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Match to sample</td>
<td>Demonstrates action with target stimulus and asks, “Find ____.”</td>
<td>Selects identical visual version of stimulus from field of 3 stimuli</td>
</tr>
<tr>
<td><strong>Dependent Measures</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Action Selection</td>
<td>Demonstrates action without stimulus and asks, “Which one does this?”</td>
<td>Selects stimulus associated with the demonstrated action from field of 3 stimuli</td>
</tr>
<tr>
<td>Action Demonstration</td>
<td>Gives participant the stimulus and asks, “Show me what this does.”</td>
<td>Demonstrates action associated with stimulus</td>
</tr>
<tr>
<td>Joining Action to Object Name</td>
<td>Asks, “Show me what a ____ does.”</td>
<td>Selects named stimulus from field of 3 stimuli and demonstrates the action associated with the stimulus</td>
</tr>
<tr>
<td>Listener</td>
<td>Asks, “Find ____.”</td>
<td>Selects named stimulus from field of 3 stimuli</td>
</tr>
<tr>
<td>Tact</td>
<td>Presents stimulus without a verbal antecedent</td>
<td>Names stimulus</td>
</tr>
<tr>
<td>Intraverbal</td>
<td>Presents stimulus and asks, “What is this?”</td>
<td>Names stimulus</td>
</tr>
<tr>
<td><strong>No Action Condition:</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Naming Experience</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Match to sample</td>
<td>Demonstrates action with target stimulus and asks, “Find ____.”</td>
<td>Selects identical visual version of stimulus from field of 3 stimuli</td>
</tr>
<tr>
<td><strong>Dependent Measures</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Listener</td>
<td>Asks, “Find ____.”</td>
<td>Selects named stimulus from field of 3 stimuli</td>
</tr>
<tr>
<td>Tact</td>
<td>Presents stimulus without a verbal antecedent</td>
<td>Names stimulus</td>
</tr>
<tr>
<td>Intraverbal</td>
<td>Presents stimulus and asks, “What is this?”</td>
<td>Names stimulus</td>
</tr>
</tbody>
</table>

Note: For all responses, one exemplar of each of the three target stimuli in the set were arranged on the table in front of the participant.
Table 6

*Summary of Interobserver Agreement (IOA) for Experiment II*

<table>
<thead>
<tr>
<th>Participant</th>
<th>Percentage of Match Instruction Sessions with IOA</th>
<th>IOA for Match Instruction Sessions</th>
<th>Percentage of Probe Trial Sessions with IOA</th>
<th>IOA for Probe Trial Sessions</th>
</tr>
</thead>
<tbody>
<tr>
<td>1a</td>
<td>42%</td>
<td>100%</td>
<td>67%</td>
<td>100%</td>
</tr>
<tr>
<td>1b</td>
<td>50%</td>
<td>100%</td>
<td>50%</td>
<td>100%</td>
</tr>
<tr>
<td>2a</td>
<td>50%</td>
<td>100%</td>
<td>67%</td>
<td>100%</td>
</tr>
<tr>
<td>2b</td>
<td>67%</td>
<td>100%</td>
<td>67%</td>
<td>100%</td>
</tr>
<tr>
<td>3a</td>
<td>17%</td>
<td>100%</td>
<td>33%</td>
<td>100%</td>
</tr>
<tr>
<td>3b</td>
<td>75%</td>
<td>100%</td>
<td>67%</td>
<td>100%</td>
</tr>
<tr>
<td>4b</td>
<td>58%</td>
<td>100%</td>
<td>67%</td>
<td>100%</td>
</tr>
</tbody>
</table>
Results and Discussion

Naming Experience with Match to Sample Instruction

The sessions of match instruction consisted of 18 learn units each, with criteria for mastery set at two consecutive sessions with 100% accuracy. Across all of the participants in the experimental condition, criterion was met within two sessions. It was unlikely that the participants would have made errors, since the required response of matching was a prerequisite repertoire for all participants.

Dependent Variables

All of the correct responses to the probe trials are summarized in Tables 7 and 8 for each participant. In addition, all of the responses are summed across participants and conditions and are presented in Figure 2. It is clear that in the action condition, the participants accurately produced the actions during the probe trials, with 96% correct responses. In comparing the listener and speaker responses in both conditions, there were more correct listener than speaker responses, regardless of the condition. When analyzing responses across the two conditions, there were more correct responses for the listener and speaker responses (98% and 79%, respectively) in the no action condition compared to the action condition (90% and 62%, respectively). The findings are discussed in greater detail as follows.
Table 7

Correct Responses Across Conditions for Participants 1a, 2a, and 3a

<table>
<thead>
<tr>
<th>Participant</th>
<th>Action</th>
<th>No Action</th>
<th>Action</th>
<th>No Action</th>
<th>Action</th>
<th>No Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>1a Listener Responses</td>
<td>6</td>
<td>6</td>
<td>5</td>
<td>6</td>
<td>3</td>
<td>6</td>
</tr>
<tr>
<td>Tact Responses</td>
<td>2</td>
<td>4</td>
<td>2</td>
<td>3</td>
<td>0</td>
<td>4</td>
</tr>
<tr>
<td>Intraverbal Responses</td>
<td>2</td>
<td>4</td>
<td>2</td>
<td>3</td>
<td>0</td>
<td>4</td>
</tr>
<tr>
<td>Action Demonstration</td>
<td>6</td>
<td>6</td>
<td>6</td>
<td>6</td>
<td>6</td>
<td>6</td>
</tr>
<tr>
<td>Joining Actions to Object Names</td>
<td>2</td>
<td>2</td>
<td>5</td>
<td>5</td>
<td>5</td>
<td>5</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Participant</th>
<th>Action</th>
<th>No Action</th>
<th>Action</th>
<th>No Action</th>
<th>Action</th>
<th>No Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>2a Listener Responses</td>
<td>6</td>
<td>6</td>
<td>6</td>
<td>6</td>
<td>6</td>
<td>6</td>
</tr>
<tr>
<td>Tact Responses</td>
<td>5</td>
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Table 8

Correct Responses Across Conditions for Participants 1b, 2b, 3b, and 4b.

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Figure 2. Percentage of correct and incorrect responses to probe trials, summarized across participants by condition.
**Probe trials for demonstration of actions.** In the experimental condition, participants were given one of the objects and asked to demonstrate its action. Participants 1a, 1b, 2a, 2b, 3a, and 4b responded with 100% accuracy for all object demonstration trials. Participant 3b responded with 72% accuracy. Overall, the participants responded with the correct action demonstration with 96% accuracy across all of the probe trials. These results are summarized in Figures 3 and 4.

**Probe trials for joining actions to object names.** Probe trials were conducted for joining actions to the object names, requiring the participant to respond as a listener by selecting the object and then demonstrating its action. These results are also summarized in Figures 3 and 4. Participants 3a and 4b responded to the probe trials with 100% accuracy across the three sets. Participants 1a, 1b, 2a, 2b, and 3b had similar response patterns, such that the initial probe trials for the first sets of stimuli had a lower number of correct responses followed increases in both or one of the second and third sets. The increases in correct responses indicate that the participants learned from the initial set what responses would be required for future sets. It is likely that the initial set resulted in a shift of stimulus control and subsequent observing responses, such that the participant attended to different aspects of the stimulus during the next instructional sessions based on prior experience. In this case, the probe trials may have evoked an observing response, resulting in the participants “noticing objects one may be asked about” (Skinner, 1957, p. 415).
Figure 3. Responses for demonstrating the actions and for joining the action to the object name for Participants 1a, 2a, and 3a.
Figure 4. Responses for demonstrating actions and joining actions to the object name for Participants 1b, 2b, 3b, and 4b.
**Probe trials for Naming.** The probe trials for Naming were conducted across both experimental and control sets, and included listener and speaker responses to the stimuli. These results are summarized by set in Figures 5 and 6 and also summarized by action and no action conditions in Figure 7. In general, the participants acquired the listener responses consistently (“Point to”) across both the action and no action conditions.

**Listener responses.** In this experiment, the listener responses were acquired with relative ease across both conditions. An effect can be observed for Participants 1a, 1b, 2b, and 3b in which there was a greater number of correct listener responses for the no action condition. Both Participants 2a and 3a showed no difference in listener responses across the two conditions while Participant 4b had fewer correct listener responses in the no action condition. These results are displayed in pie charts in Figures 8 and 9.

**Speaker responses.** In comparing the responses across the conditions, six of the seven participants had a greater number of correct responses to the speaker probe trials for the control, or no action, condition. Across all of the participants, the number of correct speaker responses for the stimuli were consistently the same as or less than the number of correct listener responses for both conditions. These data show that regardless of condition, the listener response was acquired at the same rate or more readily than the speaker responses. These results are consistent with findings from the Naming research discussed previously, in which the listener responses are acquired prior to the speaker responses. The results for these participants are consistent with those of Childers and Tomasello (2002), Hahn (2005), Hahn and Gershkoff-Stowe (2010), who also found that when actions, objects, and names were presented simultaneously, the participants effortlessly produced
the actions, and that the listener responses were acquired more often than the speaker responses.
Figure 5. Speaker and listener responses to the stimuli sorted by sets, conditions, and response topographies for Participants 1a, 2a, and 3a
Figure 6. Speaker and listener responses to the stimuli sorted by sets, conditions, and response topographies for Participants 1b, 2b, 3b, and 4b
Figure 7. Listener and Speaker probe trials for all participants, with the responses summarized across conditions.
Figure 8. Listener responses summarized for all participants across conditions. Responses are presented as the number correct out of 18 opportunities.
Figure 9. Speaker responses summarized for all participants across conditions. Responses are presented as the number correct out of 18 opportunities.
**Echoics emitted during match instruction.** Data were collected for the number of echoics demonstrations emitted during the match instruction across both conditions. These responses were not required nor consequated, and were a measure of whether or not the participant echoed while responding to the match learn unit. These data are summarized in Figures 10, 11, and 12.

During the match instruction, a difference in the number of echoics emitted was observed for all participants when compared across conditions. Five of the seven participants, Participants 1a, 1b, 2b, 3a, and 3b, emitted fewer echoics in the Action condition. So for these participants, they were less likely to emit an echoic response when the target stimulus was also assigned an action. Participants 2a and 4b emitted more echoic responses in the Action condition, although Participant 4b emitted only one additional echoic when compared to the No Action condition. The results indicate that in general, echoic responses were more likely to be emitted when the antecedent stimuli did not contain an action. In reference to observing responses, it is likely that the demonstration of an action with the stimulus selected out the participant’s attention in the experimental condition. In the control condition on the other hand, the antecedent stimuli were comprised of only the object and its name, without an action. In this case, the name of the object when tacted by the experimenter was more likely to select out the participant’s attention when the action was not present.

**Actions imitated during match instruction.** During the match instruction, all of the participants imitated the actions with the stimuli as demonstrated by the experimenter. These responses were not required and were not consequated. The experimenter measured whether the participant imitated the actions demonstrated by the experimenter with the
objects. Although variability was observed, all of the participants imitated the actions with the objects although no direction was given to do so and the participant was not reinforced for emitting the response. These data are summarized in Figures 10, 11, and 12.
Figure 10. Echoics emitted and actions imitated during the match to sample instruction of the Naming experience for Participants 1a, 2a, and 3a.
**Figure 11.** Echoics emitted and actions imitated during the match to sample instruction of the Naming experience for Participants 1b, 2b, 3b, and 4b.
Figure 12. Echoics and imitative responses emitted during match to sample instruction of the Naming experience for all participants.
Summary

In terms of stimulus control, it appears that actions demonstrated with objects select the attention of participants. These actions warranted an immediate visual observing response, while the auditory observing response for the names of the objects did not. This is not to say that the participants cannot learn the names of the objects, on the contrary, the participants were able to select named objects as a listener. But a dramatic difference was observed when participants were required to produce those names as a speaker. Based on phylogenetic or ontogenetic factors, these participants selectively acquired the see-do response of action demonstration.

One of the primary benefits of single-case design is that the results provide an opportunity to view individual differences and variations that are not apparent in a group design. Based on the results of Experiment II, it is clear that the participants’ observing responses were selected out by particular stimuli. Although there was an overall tendency to attend to the actions of the object, there were participant variations in stimulus control that can only be attributed to the collective history of reinforcement for that individual. It is impossible to experimentally control for a history of indeterminate consequences.

In order to better address variations in participant observing responses, in the third experiment, participants were selected based on their responses to multiple stimuli for one object. Specifically, participants were selected who imitated actions and responded as a listener to the stimuli, but emitted fewer speaker responses. By selecting participants whose observing responses were selected out by actions rather than names, the third experiment sought to create a common history of reinforcement to establish multiple stimulus control for observing both actions and names. The purpose of Experiment III was
to determine if a history of reinforcement could extend the scope of observing responses to include both actions and names, such that the participant consistently acquired multiple responses following contact with the stimuli.
CHAPTER IV: EXPERIMENT III

Method

Participants

The participants in this study were 7 preschool students ranging in age from 3.1 to 4.11 years old. Five of the participants were diagnosed as preschoolers with a disability, and 2 were typically developing. All of the participants were listeners and speakers. These participants were selected based on their verbal behavior developmental cusps and capabilities, with each participant having the prerequisite repertoires of generalized imitation, generalized matching, tacts, and the listener component of Naming. The presence or absence of these repertoires was established through administration of the criterion referenced *CABAS International Curriculum and Inventory of Repertoires for Children from Pre-School through Kindergarten, which is referred to as the C-PIRK* (Greer & McCorkle, 2009; Waddington & Reed, 2009) as well as the *Verbal Behavior Developmental Assessment* (Greer & Ross, 2008). The participants were recruited from the same setting as in Experiments I and II. A description of the participants is presented in Table 9.
### Participant Characteristics for Experiment III

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<th>Participant</th>
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<th>Verbal Capabilities</th>
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<td>Female/ 4.0</td>
<td>Generalized imitation Speaker Listener Full Naming Conversational Units</td>
<td>No IEP</td>
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<td>Generalized imitation Speaker Listener Full Naming</td>
<td>Preschooler with a Disability</td>
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<tr>
<td>7</td>
<td>Male/ 4.1</td>
<td>Generalized imitation Speaker Listener Listener half of Naming</td>
<td>Preschooler with a Disability</td>
</tr>
<tr>
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<td>Male/ 4.5</td>
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<td>11</td>
<td>Male/ 4.11</td>
<td>Generalized imitation Speaker Listener Full Naming</td>
<td>Preschooler with a Disability</td>
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Setting and Materials

Using the same setting as Experiments I and II, all the sessions were conducted in a nearby classroom. The sessions were conducted at a time when no other students were present to minimize distractions from competing stimuli. The sessions took place at a child-sized table with the participant seated in a child-sized chair. The experimenter was seated directly across from the participant so that the experimenter’s movements were easily viewed throughout the session. The materials were identical to those in Experiment I, and were used for both the dependent and independent variables.

To ensure that the stimuli were not familiar in either name or function to the participants, pre-experimental probe trials were conducted to determine if the name or actions associated with the stimuli were in the participant’s repertoire. Stimuli that were known to any participant in either name or function were removed from the sets prior to the experiment. The sequencing of the sets is summarized for each participant in Table 10.

Design

The experimental design was a non-concurrent multiple probe design across participants. For each participant, the procedures consisted of the Naming experience, measures of the dependent and independent variables. The dependent measures were probe trials for selection of objects associated with actions, action demonstration, listener, tact, intraverbal, and joining of an action to the object name. The independent variable was Multiple Exemplar Instruction (MEI). Different sets were used for each phase, such that between four to six sets were used for each participant. The sequencing of the sets was counterbalanced across participants.
### Table 10

Sequencing of Sets for Experiment III

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<td>2 3 4 1</td>
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<tr>
<td>11</td>
<td>5 6 - -</td>
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</table>
The sequence of the experiment was the Naming experience, with match to sample instruction, followed by probe trials for the dependent variables conducted for one set of stimuli at the outset of the experiment. This was repeated with a second set of stimuli immediately prior to the implementation of the independent variable of MEI. MEI was conducted with a new set of stimuli, until criterion was met for all responses. After mastery of MEI, the Naming experience with match to sample instruction was repeated with a new set of stimuli, followed by probe trials for the dependent variables. The alternation between MEI and measures of the dependent variables were rotated until criterion of 100% accuracy was achieved for all of the dependent variables.

Procedure

All of the experimenter antecedents and participant response topographies are outlined in Table 1.

**Naming experience: Match to sample with demonstration of function.** The procedures for the match instruction were identical to those in Experiment I and the action condition of Experiment II. Each participant received learn units for matching to sample by selecting identical visual versions of each target stimulus while hearing the experimenter tact the name of the stimulus and simultaneously demonstrating its function. Presentation of the learn units and the data collection procedures were identical to those in Experiment I.

**Dependent variables.** Measures of the dependent variables were identical to those used in Experiment I. Unlike Experiment II, echoics and imitation were not recorded during the match to sample instruction because the data did not show a clear relation to the condition or the other responses. The dependent measures included probe trials for action
selection, demonstration of actions, listener responses, tact responses, intraverbal responses, and joining an action to the object name. The probe trials were conducted using the same procedures as Experiment I.

**Pre-experimental screening.** The probe trials described in the preceding dependent variables section also served a dual purpose as a pre-experimental screening for participants. Experiment III required that all participants had similar responses to the stimuli, when the antecedent stimuli were comprised of objects, actions, and names.

Participants were selected who imitated actions, responded as a listener to the stimuli, but emitted fewer speaker responses. The responses indicated that the participants’ observing responses were selected out by actions rather than names. Participants whose responses to the probe trials differed from the selection criteria were not included in the experiment.

Initially, probe trials for the dependent measures were conducted for each of the participants at the outset of the experiment. Prior to implementing the MEI intervention, these measures were repeated using a new set of stimuli. Repetition of the dependent measures prior to the intervention was used to control for maturation or other variables that may have affected participant responding. If there was an increase in the number of correct responses to the dependent measures in the second set, match instruction and probe trials for the dependent measures were conducted for additional sets of stimuli until stable responding or a descending trend was observed prior to implementing the intervention. Provided that the dependent measures were consistent across the first and second sets, or there were fewer correct responses for the second set, the independent variable of MEI was implemented. After completion of MEI, the post-experimental Naming experience with
match to sample instruction was presented followed by probe trials for the dependent variables.

**Independent variable.**

*Multiple exemplar instruction with demonstration of function.* After obtaining the pre-experimental measures of the dependent variables, the experimenter implemented the independent variable of multiple exemplar instruction (MEI). Using a new set of stimuli, the experimenter presented learn units for four different responses to each stimulus: 1) imitating actions, 2) listener, 3) tact, and 4) intraverbal responses. All responses were conseuated with reinforcement or correction as appropriate. For the learn units for imitating actions, the antecedent consisted of the experimenter saying, “Do this,” and demonstrating the function of the object. The participant was required to select the visual match from a field of three stimuli presented on the table and imitate the action. For the listener responses, the antecedent was delivered as “Find ____,” while the participant selected the named stimulus from a field of three stimuli presented on the table. For the tact responses, the experimenter presented the stimulus without a verbal antecedent for the participant to tact. For the intraverbal responses, the experimenter demonstrated the action with the stimulus and asked, “What’s this?” The field of three stimuli remained on the table in front of the participant throughout all of the responses. The participant received reinforcement in the form of praise, social attention, or tokens for emitting correct responses to learn units. For incorrect responses, the experimenter modeled the correct response for the participant to imitate or echo, but did not reinforce the correction. Correct and incorrect responses were recorded for all of the response topographies for each stimulus.
The action imitation, listener, intraverbal, and tact learn units were rotated across all three of the stimuli, such that consecutive learn units did not consist of responses to the same stimulus. For example, an action imitation learn unit was presented for stimulus A, followed by a listener learn unit for stimulus B, and a speaker learn unit for stimulus C. The learn units were rotated across the stimuli and response forms until all of the responses were mastered concurrently. A session consisted of 24 learn units, comprised of six learn units per response form for the action imitation, listener, intraverbal, and tact responses. Criterion was set at 100% accuracy for one session.

**Post MEI measures of the dependent variables.** Following mastery of the multiple exemplar instruction, the Naming experience with match to sample instruction was followed by unconsequated probe trials for the dependent variables with a new set of stimuli. These were identical to those presented prior to the MEI intervention. Criterion for mastery of the dependent measures was set at 100% accuracy across the six response topographies. If the participant met criterion with the novel set following MEI, then it was determined that the participant had acquired multiple stimulus control and the necessary observing responses to learn multiple responses from a single experience.

On the other hand, if criterion was not met for the post MEI measures of the dependent variables, the participant repeated MEI with a new set of stimuli, until criterion was achieved. Again, the post MEI measures of the dependent variables were repeated. If criterion was achieved, the participant was considered to have acquired multiple stimulus control as described above. Otherwise, this sequence in which MEI was rotated with measures of the dependent variables was repeated until criterion was met. The experimental sequence is summarized in Figure 13.
Table 11

**Antecedents and Responses Across Conditions**

<table>
<thead>
<tr>
<th>Response</th>
<th>Experimenter Antecedent</th>
<th>Target Participant Response</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Naming Experience</strong></td>
<td>Match to sample, Demonstrates action with target stimulus and asks, “Find _____.”</td>
<td>Selects identical visual version of stimulus from field of 3 stimuli</td>
</tr>
<tr>
<td><strong>Dependent Measures</strong></td>
<td>Action Selection, Demonstrates action without stimulus and asks, “Which one does this?”</td>
<td>Selects stimulus associated with the demonstrated action from field of 3 stimuli</td>
</tr>
<tr>
<td></td>
<td>Action Demonstration, Gives participant the stimulus and asks, “Show me what this does.”</td>
<td>Demonstrates action associated with stimulus</td>
</tr>
<tr>
<td><strong>Joining Action to Object Name</strong></td>
<td>Asks, “Show me what a ____ does.”</td>
<td>Selects named stimulus from field of 3 stimuli and demonstrates the action associated with the stimulus</td>
</tr>
<tr>
<td><strong>Listener</strong></td>
<td>Asks, “Find ____.”</td>
<td>Selects named stimulus from field of 3 stimuli</td>
</tr>
<tr>
<td><strong>Tact</strong></td>
<td>Presents stimulus without a verbal antecedent</td>
<td>Names stimulus</td>
</tr>
<tr>
<td><strong>Intraverbal</strong></td>
<td>Presents stimulus and asks, “What is this?”</td>
<td>Names stimulus</td>
</tr>
<tr>
<td><strong>MEI</strong></td>
<td>Action Imitation, Demonstrates action with a stimulus, and asks, &quot;Do this.&quot;</td>
<td>Imitates demonstrated action with identical visual version of the stimulus</td>
</tr>
<tr>
<td><strong>Listener</strong></td>
<td>Asks, “Find ____.”</td>
<td>Selects named object from field of 3 stimuli</td>
</tr>
<tr>
<td><strong>Intraverbal</strong></td>
<td>Presents stimulus while demonstrating the action and asks, “What’s this?”</td>
<td>Names stimulus</td>
</tr>
<tr>
<td><strong>Tact</strong></td>
<td>Presents stimulus without a verbal antecedent</td>
<td>Names stimulus</td>
</tr>
</tbody>
</table>

Note: For all responses, one exemplar of each of the three target stimuli in the set were arranged on the table in front of the participant.
Figure 13. The experimental sequence for measures of the dependent variables and Multiple Exemplar Instruction (MEI)
Interobserver Agreement and Procedural Fidelity

Identical to Experiment I, interobserver agreement (IOA) was collected for match instruction, probe trials, and MEI. Table 12 summarizes IOA and procedural fidelity for Experiment III.
Table 12

*Summary of Interobserver Agreement (IOA) for Experiment III*

<table>
<thead>
<tr>
<th>Participant</th>
<th>Percentage of Match Sessions with IOA</th>
<th>IOA for Match Sessions</th>
<th>Percentage of Probe Sessions with IOA</th>
<th>IOA for Probe Sessions</th>
<th>Percentage of MEI Sessions with IOA</th>
<th>IOA for MEI Sessions</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>67%</td>
<td>100%</td>
<td>67%</td>
<td>95%</td>
<td>33%</td>
<td>98%</td>
</tr>
<tr>
<td>6</td>
<td>50%</td>
<td>100%</td>
<td>100%</td>
<td>100%</td>
<td>33%</td>
<td>98%</td>
</tr>
<tr>
<td>7</td>
<td>33%</td>
<td>100%</td>
<td>100%</td>
<td>99%</td>
<td>60%</td>
<td>99%</td>
</tr>
<tr>
<td>8</td>
<td>33%</td>
<td>100%</td>
<td>100%</td>
<td>99%</td>
<td>33%</td>
<td>100%</td>
</tr>
<tr>
<td>9</td>
<td>50%</td>
<td>100%</td>
<td>67%</td>
<td>100%</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>10</td>
<td>38%</td>
<td>100%</td>
<td>50%</td>
<td>100%</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>11</td>
<td>50%</td>
<td>100%</td>
<td>50%</td>
<td>100%</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>
Results and Discussion

Before reviewing the results from Experiment III, it is necessary to note that variations in participant responses to the initial sets probe trials resulted in a division of participants into two distinct groups. The two groups will be referred to as the MEI group, with Participants 5, 6, 7, and 8, and the Repeated Probe group, with Participants 9, 10, and 11, which will be discussed respectively. The results for the MEI group are summarized in Figures 14, 15, and Table 13. The results for the Repeated Probe Group are summarized in Figures 16 and 17.

Pre-experimental Match to Sample Instruction

The sessions of match instruction consisted of 18 learn units each, with criteria for mastery set at two consecutive sessions with 100% accuracy. Across all of the participants in the experimental condition, criterion was met within two sessions. It was unlikely that the participants would have made errors, since the required response of matching was a prerequisite repertoire for all participants.

Pre-experimental Measures of the Dependent Variables

Probe trials for selection of objects associated with actions. In these probe trials, the experimenter demonstrated the actions associated with an object, but did not use the object. Only the motion was demonstrated and the participant was then asked to select the object associated with that action. All of the participants selected the correct object with 100% accuracy across all of the sets, and the results are summarized in Figure 14.
Table 13

**Summary of Responses for Participants 5, 6, 7, and 8**

### Participant 5

<table>
<thead>
<tr>
<th></th>
<th>Pre-Probe #1</th>
<th>Pre-Probe #2</th>
<th>Post Probe #1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Listener Responses</td>
<td>6</td>
<td>6</td>
<td>6</td>
</tr>
<tr>
<td>Tact Responses</td>
<td>4</td>
<td>2</td>
<td>6</td>
</tr>
<tr>
<td>Intraverbal Responses</td>
<td>5</td>
<td>2</td>
<td>6</td>
</tr>
<tr>
<td>Action Selection</td>
<td>6</td>
<td>6</td>
<td>6</td>
</tr>
<tr>
<td>Action Demonstration</td>
<td>6</td>
<td>6</td>
<td>6</td>
</tr>
<tr>
<td>Joining Actions to Object Names</td>
<td>6</td>
<td>6</td>
<td>6</td>
</tr>
</tbody>
</table>

### Participant 6

<table>
<thead>
<tr>
<th></th>
<th>Pre-Probe #1</th>
<th>Pre-Probe #2</th>
<th>Post Probe #1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Listener Responses</td>
<td>6</td>
<td>5</td>
<td>6</td>
</tr>
<tr>
<td>Tact Responses</td>
<td>2</td>
<td>2</td>
<td>6</td>
</tr>
<tr>
<td>Intraverbal Responses</td>
<td>2</td>
<td>2</td>
<td>6</td>
</tr>
<tr>
<td>Action Selection</td>
<td>6</td>
<td>6</td>
<td>6</td>
</tr>
<tr>
<td>Action Demonstration</td>
<td>6</td>
<td>6</td>
<td>6</td>
</tr>
<tr>
<td>Joining Actions to Object Names</td>
<td>6</td>
<td>5</td>
<td>6</td>
</tr>
</tbody>
</table>

### Participant 7

<table>
<thead>
<tr>
<th></th>
<th>Pre-Probe #1</th>
<th>Pre-Probe #2</th>
<th>Post Probe #1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Listener Responses</td>
<td>6</td>
<td>6</td>
<td>6</td>
</tr>
<tr>
<td>Tact Responses</td>
<td>4</td>
<td>3</td>
<td>6</td>
</tr>
<tr>
<td>Intraverbal Responses</td>
<td>5</td>
<td>2</td>
<td>6</td>
</tr>
<tr>
<td>Action Selection</td>
<td>6</td>
<td>6</td>
<td>6</td>
</tr>
<tr>
<td>Action Demonstration</td>
<td>6</td>
<td>6</td>
<td>6</td>
</tr>
<tr>
<td>Joining Actions to Object Names</td>
<td>6</td>
<td>6</td>
<td>6</td>
</tr>
</tbody>
</table>

### Participant 8

<table>
<thead>
<tr>
<th></th>
<th>Pre-Probe #1</th>
<th>Pre-Probe #2</th>
<th>Post Probe #1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Listener Responses</td>
<td>6</td>
<td>6</td>
<td>6</td>
</tr>
<tr>
<td>Tact Responses</td>
<td>4</td>
<td>2</td>
<td>6</td>
</tr>
<tr>
<td>Intraverbal Responses</td>
<td>4</td>
<td>2</td>
<td>6</td>
</tr>
<tr>
<td>Action Selection</td>
<td>6</td>
<td>6</td>
<td>6</td>
</tr>
<tr>
<td>Action Demonstration</td>
<td>6</td>
<td>6</td>
<td>6</td>
</tr>
<tr>
<td>Joining Actions to Object Names</td>
<td>4</td>
<td>6</td>
<td>6</td>
</tr>
</tbody>
</table>
Figure 14. Action responses prior to and following the MEI intervention for Participants 5, 6, 7, and 8.
Figure 15. Listener and speaker responses prior to and following the MEI intervention for Participants 5, 6, 7, and 8
**Probe trials for action demonstration.** In the probe trials for action demonstration, participants were given one of the objects and asked to demonstrate its action. All of the participants responded with 100% accuracy for all object demonstration trials across all of the sets, and the results are summarized in Figure 14.

**Probe trials for joining an action to object name.** In the probe trials for joining an action to the object name, participants were required to select the named object and demonstrate its function, and the results are summarized in Figure 14. Participants responded with 100% accuracy across both sets, with two exceptions. Participant 6 responded with 100% and 83% accuracy. Participant 8 responded with 100% and 67% accuracy.

**Probe trials for Naming.** The probe trials for listener and speaker responses were repeated with two sets for each participant prior to the MEI intervention, and the results are summarized in Figure 15. Participants 5, 7, and 8 responded with 100% accuracy to all probe trials for the listener responses for both sets of stimuli prior to the MEI intervention. Participant 6 responded with 100% accuracy for the first set and 83% accuracy for the second set. For the tact responses, Participant 5 responded with 67% and 33% accuracy. Participant 6 responded with 33% accuracy to both sets. Participant 7 responded with 67% and 50% accuracy. Participant 8 responded with 67% and 33% accuracy. For the intraverbal responses, Participant 5 responded with 83% and 33% accuracy. Participant 6 responded with 33% accuracy to both sets. Participant 7 responded with 83% and 33% accuracy. Participant 8 responded with 67% and 33% accuracy.

**Multiple Exemplar Instruction (MEI)**
Each participant received multiple sessions of MEI until the criterion was met with 100% accuracy across all responses. The number of sessions required to meet criterion varied across participants, although all of the participants only required MEI for one set of stimuli. Participants 5 and 6 required six sessions, Participant 7 required five, and Participant 8 required three.

**Post MEI Match to Sample Instruction**

The sessions of match instruction consisted of 18 learn units each, with criteria for mastery set at two consecutive sessions with 100% accuracy. Across all of the participants in the experimental condition, criterion was met within two sessions. It was unlikely that the participants would have made errors, since the required response of matching was a prerequisite repertoire for all participants.

**Post MEI Measures of the Dependent Variables**

After mastery of the match to sample instruction for a novel set of stimuli, probe trials were presented for the six dependent measures: 1) selection of actions associated with objects, 2) action demonstration, 3) joining an action to an object name, 4) listener responses, 5) tact responses, and 6) intraverbal responses. All of the participants responded with 100% accuracy across all of the probe trials for the six dependent measures following MEI instruction, and the results are summarized in Figure #. Prior to the MEI intervention, the responses were not only below criterion level for mastery, but also indicated a descending trend in correct responses across sets. Since each participant met criterion with the novel set following MEI, then it was determined that the participant had
acquired multiple stimulus control and the necessary observing responses to learn multiple responses from a single experience.

**Summary of MEI Condition**

For this experiment, participant selection required that each participant readily acquire actions and listener responses to the stimuli, but acquire fewer speaker responses. Prior to and following the MEI intervention, the participants selected objects associated with an action, demonstrated an action, and joined an action to an object name. These responses are consistent with the results from the previous two experiments, which indicated that actions are acquired with relative ease. Similarly, the participants acquired the listener responses to the stimuli prior to and following the MEI intervention. These results are also consistent with those of the first and second experiments. The participants learned the names of the stimuli as a listener, and selected the correct objects when they were named. Acquisition of the names as a listener did not extend to the accuracy of the speaker responses, which consistently had fewer correct responses prior to the MEI intervention. Based on the responses prior to MEI, it is clear that actions and names as a listener selected out the observing responses of the participants.

Each of the four participants received varied numbers of MEI sessions, dependent on the individual rate of acquisition. But following mastery of MEI, all of the participants responded to all of the probe trials for the dependent measures with 100% accuracy. Instructionally, MEI provided rotated opportunities for multiple responses to the same stimuli in the presence of reinforcement. Following this cumulative history of reinforcement for multiple responses to stimuli, the participants acquired multiple responses to probe trials for the novel set of stimuli. Most notably, the participants
acquired speaker responses to the stimuli as a result of exposure to the Naming experience. Prior to MEI, the participants inconsistently acquired few speaker responses, indicating that the names did not select out observing responses. The increased speaker responses following MEI indicated that observing responses and stimulus control shifted as a result of the intervention.

As an instructional intervention, MEI pairs reinforcement with the rotated opportunities for multiple response topographies for a stimulus. Results from multiple experiments have shown that MEI is an effective intervention for inducing the critical language acquisition capability of Naming. Acquisition of Naming allows a child to incidentally acquire language from naturally occurring environmental contact, such that hearing a word spoken in reference to an object (“Look, it’s a swan!”) can result in learning “swan” as both a listener and speaker. The Naming capability allows us to learn language outside of the direct instructional setting, and accounts for the majority of a child’s growing vocabulary.

When the procedure of MEI and the capability of Naming are reduced to the underlying principles of behavior, it becomes apparent that reinforcement underlies both the intervention and the capability. It is a history of reinforcement that shapes observing responses and stimulus control, and MEI creates a history of reinforcement for multiple responses. In this case, MEI creates a history of reinforcement for actions, listener, and speaker responses, which results in a shift of stimulus control such that both names and actions select out the observing responses of the individual. In reference to the Colavita effect (Colavita, 1974; Spence, 2009), visual stimuli such as actions, select out observing responses over auditory stimuli, such as names. MEI establishes a history of reinforcement
that overrides this general tendency, allowing the individual to simultaneously acquire names and actions of objects.

**Repeated Probe Group**

During the initial probe trials, the data for Participants 9, 10, and 11 showed an ascending trend for each successive set of Naming probe trials. According to the procedures, a stable or descending trend was required prior to implementing the MEI intervention. Conversely, if the subsequent sets of the dependent measures continued to demonstrate an ascending trend, the measures were repeated with additional sets until criterion for the dependent measures was achieved. So for these participants, the sessions of probe trials were repeated with novel sets, and the correct responses continued to increase until the mastery criterion of 100% correct responding was achieved by Participant 9 in the third set of probe trials, Participant 10 in the fourth set of probe trials, and Participant 11 in the second set. For the action probe trials, all of the participants responded with 100% accuracy, with the exception of Participant 9 who responded with 83% accuracy in the first session of joining an action to an object name. These results are summarized in Figures 16 and 17. Although these results were unexpected, they provide additional information that warrants inclusion and discussion.

The participant responses to the repeated probe sessions could indicate a different learning strategy when confronted with multisensory stimuli. In the initial set of probe trials, actions selected out the participants observing responses, and they acquired the actions. In this initial session, the participants did not attend to the object names and they produced few responses as a speaker. But, in subsequent sessions, a steady increase could be observed in correct speaker responses to the new sets of stimuli. It is possible that
having acquired the actions in the first set, but not the names, on each successive set the names of the objects began to select out the participants observing responses. In this case, the participants sequentially acquired first actions, and then names across the series of probe sessions.
Figure 16. Correct listener and speaker responses for repeated probe sessions across novel sets of stimuli for Participants 9, 10, and 11
Figure 17. Action responses for repeated probe sessions across novel sets of stimuli for Participants 9, 10, and 11
These results stand in contrast to those of Experiment II. In that case, the participants were presented with probe trials for six sets of stimuli, of which three contained actions. Despite the repetition of these probe sessions, the participants had variable responding across the series of probes. If repetition of the probe sessions alone was sufficient to acquire the Naming responses to the set of stimuli, then the data for those participants should have had an overall ascending trend across sessions. This was not the case. The differences between the responses to the reversal probe sessions of Experiment II and the responses to the repeated probe sessions with actions of Experiment III suggest that the difference lies in the repetition of the action condition. When the conditions of the probe sessions were rotated with and without actions, no overall trends were found. But for these participants with repeated probe sessions with actions, an ascending trend and eventual acquisition of the Naming responses occurred.

During the probe sessions, the responses were not consequated, but most importantly, the correct responses were not reinforced by the experimenter. Despite the lack of prosthetic reinforcement, their correct responses increased with each successive set of stimuli. Research has established that correct responses increase in the presence of positive reinforcement. This reinforcement can be prosthetic, in the form of tokens, praise, or edibles. Reinforcement can also occur without an external source. In this case, the reinforcement is better characterized as natural or conditioned reinforcement. Natural reinforcement occurs in the case of generalized imitation, in which the correspondence between one’s own actions and those of a model functions as a reinforcer. In the match to sample instruction during the Naming experience, the participants often imitated the actions associated with the objects although the actions were not a required response. Also,
during the probe trials for Experiment I, II, and III, the participants readily and consistently acquired the action selection and action demonstration responses. It is possible that actions not only selected out the observing responses of the participants, but also functioned as a conditioned reinforcer.

For the participants in the Repeated Probe conditions, increases in correct responses indicate that some form of reinforcement was present. Since the probe trials were unconsequated, the source of reinforcement was not prosthetic, suggesting that natural reinforcement was present. Although these results are separate from the MEI condition, they raise additional points that are worth consideration. These results suggest that for some participants, the presence of actions and the opportunity to imitate those actions may function as a reinforcer for observing both names and actions, which then affects subsequent listener and speaker responses to the stimuli. Not unlike the MEI condition, the repetition of the probe trials creates an opportunity to respond to each stimulus with multiple responses. If the actions function as a reinforcer for observing the names of the stimulus, the repeated probe sessions similarly create a history of reinforcement for acquiring multiple responses to one stimulus.
CHAPTER V: GENERAL DISCUSSION

Summary of Findings

Taken as a whole, the results of the three experiments give a clearer picture of the relationship between actions and object names in language acquisition. It has been suggested that the presence of an action can hinder, or in some cases facilitate the acquisition of names. These experiments dissected the relations among object, name, and action, to reveal a complex interaction of conditioned reinforcement and observing responses unique to the individual. In relation to the “Colavita effect” (Spence, 2009), these experiments establish that actions, as a visual stimulus, consistently select out observing responses, while observing responses for names varies widely. Reduced to the basic principles, stimulus control for objects or actions is established through a cumulative history of reinforcement, determining which stimuli select out observing responses. Observing responses then determine which aspects of multi-sensory stimuli are available to the individual.

The results of the first experiment demonstrated that for these participants as a group, when presented with a multi-sensory stimulus, actions selected out observing responses over names. The participants readily acquired the actions associated with the objects, but learned fewer names. Experiment I provided a snapshot of the general tendencies of this age group and population when actions and names were presented simultaneously. Experiment II was designed to compare acquisition of names in action and no action conditions for each individual. These results were useful in comparing whether an action facilitated or hindered name acquisition. The results showed a difference in acquisition of object names when presented with and without actions. Again, when an action was present,
it selected out the observing responses of the participants over names. And when comparing the action and no action condition, the participants acquired more names in the no action condition.

An important finding from the alternating treatments design from Experiment II was the inter- and intra-subject variability in responses. These variations suggest that for each individual, it is the cumulative history of reinforcement and punishment that establishes the stimulus control of actions and objects, which in turn dictates observing responses. Although it is experimentally impossible to control for the experiences of each participant, Experiment III was designed to select participants with similar responses to the stimuli, indicating similar observing responses. In the third experiment, the participants were presented multiple rotated opportunities to respond to the actions and names associated with the stimulus, and those correct responses were consequated with reinforcement. After this intervention, the participants consistently acquired multiple responses when the stimulus contained an object, action, and name. Establishing a history of reinforcement for attending to multiple aspects of a singular stimulus allowed the participants to acquire multiple responses to a single stimulus, when prior to the intervention, they could not.

Having observed that reinforcement underlies the observing responses and stimulus control necessary for acquiring multiple responses, the results for the repeated probe participants in the third experiment can be similarly evaluated in terms of reinforcement. For these participants, repeated unconsequated probe trials across sets of stimuli were sufficient to acquire multiple responses to a single stimulus, while initially, they could not. The most basic principle of behavior is that positive reinforcement increases behavior. In this case, the behavior increased, but reinforcement was not provided from an external or
prosthetic source. Although it cannot be determined conclusively, it appears that natural reinforcement was present. It is possible for these participants, the actions functioned as a conditioned reinforcer for observing the names. In this case, the presence of actions facilitated rather than hindered acquisition of object names.

**Conditioned Reinforcement in Language Acquisition**

The focus of this series of experiments was the acquisition of multiple responses to a single stimulus through incidental contact, outside the instructional setting. This ties closely to the capability of Naming, which allows one to observe a stimulus, hear its name, and subsequently acquire the name-object relation as both a speaker and a listener. Naming is thought to account for the rapid expansion of vocabulary in young children, and is critical to language development (Greer & Longano, 2010). In most typically developing children, Naming emerges innately, but for some children an intensive intervention is required to induce the capability. Various interventions have been successful for inducing Naming, but underlying all of these interventions is the pairing of reinforcement with the visual and auditory observing responses necessary to acquire language. Knowing how Naming is induced experimentally also sheds some light on its development in children without intervention. A conditioned reinforcer must be present such that during the Naming experience, the observing responses of the individual selects out visual and auditory stimuli, which in turn results in the acquisition of names for objects (Longano & Greer, 2013).

When evaluating the source of reinforcement in Naming, Longano and Greer (2013) looked at the role of conditioned reinforcement for observing visual and auditory stimuli. For participants without Naming, the researchers systematically paired reinforcement with
observing responses for non-preferred visual and auditory stimuli on a computer screen. The stimuli were then combined, such that an animated visual stimulus was presented while the recorded auditory stimulus (object name) was tacted for four stimuli in a set. No prosthetic reinforcement was provided while the participants observed the simultaneous stimulus presentation, and after multiple observations of the paired stimuli, the participants acquired the names of the stimuli. Additional probe trials with novel sets of stimuli confirmed that the participants acquired the capability of Naming as a result of this procedure.

The researchers suggest that the Naming capability requires the joining of visual and auditory stimuli as conditioned reinforced. In this case, establishing a history of conditioned reinforcement for observing multiple aspects of a stimulus was sufficient to induce the capability of Naming, which then allows for incidental acquisition of language. These findings closely parallel the findings from the present series of experiments. Establishing a history of reinforcement for observing visual and auditory stimuli resulted in acquisition of multiple responses from a single experience. These interventions allowed children to learn from incidental environmental exposures, which provides exponentially more learning opportunities.

**Educational Implications and Applications**

The findings from these three basic science experiments are the first step towards a better understanding of teaching methodology and learner success. From these experiments, it becomes apparent that presenting multiple pieces of information does not necessarily benefit the learner. In fact, the different aspects are more likely to compete for attention than to facilitate multiple responses. But, the findings from the third experiment
have the greatest instructional implications. By establishing which aspect of the stimulus that the student is attending to, the teacher can then identify which aspect has acquired stimulus control, and more importantly, which one has not. The MEI procedure from Experiment III was successfully used to shift stimulus control such that the participants attended to multiple aspects of the stimulus and subsequently acquired multiple responses. Rather than replacing one observing response with another, the MEI intervention conditioned multiple simultaneous observing responses. After the intervention, both visual and auditory stimuli selected out observing responses. Instructionally, initially identifying student deficits in attending then allows for intervention to maximize learning multiple responses from demonstration.

Although a teacher may demonstrate a math problem or science experiment while describing the steps, the students may only attend to the visual presentation or auditory aspects. Greer, Corwin, and Buttigieg (2010) found that students without the capability for Naming did not benefit from the common teaching practice of modeling. Successful learning in the typical classroom setting requires that students observe and learn from teacher demonstrations. These students lacked the capability for Naming, necessary for incidental language learning. By implementing an MEI intervention, the researcher found that pairing reinforcement with multiple responses to a stimulus induced Naming. This capability not only allowed for incidental language acquisition, but the ability to learn from teacher demonstration. Essentially, this intervention provided students with the observing responses that are critical to learning in the classroom setting. This capability might ultimately be the deciding factor for success or failure in school.
Singer and Goldin-Meadow (2005) conducted similar research into the relation between teaching methods, instructional modalities, and student learning. They compared combinations of gestural and verbal instruction for solving mathematical problems. When verbal and gestural methods were used simultaneously, the children had more correct responses than either method in isolation. The verbal and gestural instruction provided two complementary but different methods to solve the problem. In this research, the combination of instructional modalities facilitated learning. It is possible that participants attended to only one or both the verbal and gestural methods. In this case, the presence of visual and auditory stimuli facilitated learning.

The research from Singer and Goldin-Meadow (2005), taken into account with the findings from the present experiment and those from both Corwin and Greer (in press) and Greer, Corwin, and Butttigieg (2010), adds another piece to the puzzle. These findings together indicate that learning from both auditory and visual instruction requires prerequisite capabilities, and that those capabilities can be induced through an instructional intervention. Once the students had acquired conditioned reinforcement for observing multiple instructional components, they benefitted from instruction in a way that they could not before. The Singer and Goldin-Meadow participants most likely had a history of reinforcement for attending to multiple stimuli during instruction, and had the necessary prerequisites to benefit from instruction. Also, the experimenters provided two different methods to solve the problem, one using visual presentation and the other using auditory. It is possible that the participants selectively attended to only one method, but were still able to solve the problems. It cannot be determined which method or if both selected out the participants attention, unless different responses were acquired.
There is an implicit assumption in most classrooms that when the teacher presents a lesson with demonstration, modeling, and description, that the students should learn through observation. The accumulation of recent research suggests otherwise; there are critical prerequisite repertoires required for learning from teacher presentations. Optimally, teachers should approach learners as individuals and evaluate what methods are successful. If students are attending selectively to portions of the instruction and are not learning, then interventions can be implemented for those students who cannot learn from traditional methods. Educational research has afforded us with tools that can help not only to prevent student failure, but also accelerate learning. Initial assessment and intervention are crucial to student success.

**Limitations**

There were several limitations in the series of experiments. Across all of the experiments, a limitation was the possible ceiling effect due to the number of stimuli presented in the set. Only three stimuli were presented, which only required participants to learn three object-action-name associations. The participants consistently acquired the object-action association without errors. Presenting more stimuli would have increased the number of object-action-name associations, and potentially allowed for greater differentiation in acquisition across and within participants.

In Experiment I, a larger subject group would have been preferable. Also, in the Hahn and Gershkoff-Stowe (2010) experiment, the researchers measured participant responses after each exposure to the stimuli. Having a series of measures of the dependent variables allowed the researchers to measure the change in responses following each training session and to evaluate whether actions or object names were more affected by repeated exposures.
In future replications it would be relevant to repeat these measures. In Experiment II, again it would have been beneficial to have included additional participants, which would have allowed for not only a visual analysis of the alternating treatments design, but also statistical analysis. In addition, it may not be necessary to have six phases of probes across the two conditions. The difference in responses should be equally apparent in four phases, and limit the possibility of extinction. Experiment II and III included two speaker responses, tact and intraverbal. The inclusion of both responses was redundant, and could have been limited to only the intraverbal response. Also, in Experiment III, it would have been beneficial to have included more participants in both the MEI and repeated probe conditions. Based on the participant responses in Experiment III, there were clearly differences among the participants beyond basic capabilities. Although the differences in the two groups of participants is not immediately apparent, a finer grained analysis of capabilities and conditioned reinforcers could determine exactly why there were such divergent responses from the two groups.

**Future Research**

This series of experiments was designed to answer the fundamental question of what children attend to, and how that affects learning. It is clear that actions select out observing responses over names, but given a history of reinforcement, children can learn both actions and names. The next stage of research should extend into the classroom and address observing responses during instruction. It is relevant to measure what aspects of instruction are selecting out student attention. Effective teaching is measured not by the behavior of the teacher, but instead by the learning of the students. In effect, student responses are the dependent measure of teaching. Creating an assessment procedure for
observing responses during instruction will allow teachers to determine if the presentation methods are effective for individual students. The results from Experiment III established that a reinforcement-based intervention was effective in altering the students’ observing responses, enabling them to learn multiple responses from instruction. These findings should be extended to develop interventions to induce the necessary prerequisite capabilities required to learn from instructional presentations in the classroom setting.

Another possible line of research could address the role of actions and imitation as a conditioned reinforcer for acquiring other responses. In Experiment III, some of the participants acquired both actions and names after a series of exposures to unconsequated probe trials. The increase in correct responses for names and immediate acquisition of actions, both in conjunction with the lack of prosthetic reinforcement suggest that actions functioned as a conditioned reinforcer. After pairings of actions as the conditioned reinforcer with names, these participants acquired the observing responses necessary to acquire the names.

These findings taken into account with those of Longano and Greer (2013) imply that action imitation could be used as a conditioned reinforcer to facilitate language acquisition. Further research could evaluate the effect of successive pairing of actions as reinforcement for observing names on simultaneous language acquisition. In one of the first analyses of the relations between actions, objects, and names, Hahn (2005) proposed that a symbiotic joining of names and actions could be beneficial for language acquisition:

Children’s propensity to learn actions may be exploited to facilitate vocabulary growth if the two can be yoked together. By integrating labels and actions into a single unit of
memory, words may ride on the coattails of actions, thus easing the cognitive burden that is associated with their production. (p. 128)

Although the language may differ from behavioral terminology, the principles of conditioned reinforcement and observing responses remain the same.

**Conclusion**

It is our history of reinforcement that determines which stimuli are salient and will select out our observing responses. Each individual has his or her own accumulation of experiences that shape observing responses. But the present research demonstrates that stimulus control and observing responses are not static, rather they can be shifted through an experimentally manipulated history of reinforcement. Despite predispositions, consistent pairing of reinforcement with observing responses allows a child to contact new stimuli, and acquire new responses. This implies that educational interventions should focus not on teaching repertoires, but instead on changing conditioned reinforcers for students which will in turn allow them to learn in new ways that were not possible before.
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