Effects of Mastery of Auditory Match-to-Sample Instruction on Echoics, Emergence of Advanced Listener Literacy, and Speaker as Own Listener Cusps by Elementary School Students with ASD and ADHD

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ABSTRACT

Effects of Mastery of Auditory Match-to-Sample Instruction on Echoics, Emergence of Advanced Listener Literacy, and Speaker as Own Listener Cusps by Elementary School Students with ASD and ADHD

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I tested the effects of mastery of an advanced auditory match-to-sample (MTS) instruction on the emission of full echoic responses, and the emergence of advanced listener literacy and speaker-as-own-listener cusps. In two experiments, an advanced auditory MTS instruction was implemented, in which the auditory MTS Flash® instructional program displayed a computer screen containing one button at the top center of the screen and two buttons below it in the bottom corners of the screen. The top button produced the sample word or phrase, and the two buttons located below produced the exemplar and non-exemplar word or phrase. In the advanced auditory match-to-sample instruction, the participant mastered MTS for words or phrases. In Experiment 1, a counterbalanced delayed multiple probe across participants design was implemented to test the effects of mastery of an advanced auditory MTS instruction on the emergence of advanced listener literacy and Naming, and the emission of full echoic responses. In Experiment 2, a time lagged multiple probe across participants design was implemented to test the effects of mastery of the advanced auditory MTS instruction on the emergence of advanced listener literacy

and speaker-as-own-listener cusps (i.e., Naming, say-do correspondence, and self-talk). In addition, Experiment 2 investigated the potential sources of the emergence of advanced listener literacy and speaker-as-own-listener cusps using the probe procedure to identify the degree of conditioned reinforcement for voices. Full echoic responses across all participants significantly improved as a function of the advanced auditory MTS instruction. In Experiment 1, two out of four participants achieved full Naming. In Experiment 2, one out of three participants achieved full Naming. Two participants' self-talk and say-do correspondences significantly increased. Mastery of the protocol also resulted in increased reinforcement for choosing to listen to recorded speech.

Keywords: Auditory Match-to-Sample, Naming, Conditioned Reinforcement for Voices, Speaker-as-own-Listener, Self-talks, Conversational Units

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DEDICATION

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Chapter I

INTRODUCTORY CHAPER

The purpose of the research reported here was to systematically test the effects of mastery of an advanced auditory match-to-sample (MTS) instruction on student's listener literacy, Naming, self-talk, say-do correspondence, and conversational units. The procedure represented extension of a previously tested protocol, involving participants' acquisition of more elaborate auditory MTS responses—hence the use of the phrase "advanced auditory matching." The findings from the current study may shed additional light on the sources for other verbal behavior developmental cusps (Greer & Speckman, 2009; Greer & Ross, 2008; Greer & Keohane, 2006) including the emergence of speaker-as-own listener cusps and provision of a better understanding of the incidental acquisition of language (i.e., language functions acquired without direct reinforcement and instruction).

According to current linguistic research, children initially acquire language through a process which typically occurs with sensory and intellectual experiences (Saffran, Newport, Aslin, Tunick, & Barrueco, 1997). The process of acquiring language is incidental rather than intention of learning activities (Chomsky, 1975). Reber (1967) argued incidental learning of new words involves the unconscious and unintentional acquisition of abstract information.

According to verbal developmental theory, the speaker-as-own listener verbal developmental cusps result in complex verbal beh7avior (Greer & Keohane, 2006;

Greer & Longano, 2010; Greer & Ross, 2008; Greer & Speckman, 2009). These cusps may explain how humans can come to emit unique and complex verbal behaviors without direct instruction. The listener function is now identified as a critical component in the development of verbal functions and the role of the listener in verbal behavior has been experimentally documented in the last decade, thereby extending and providing a more complete Skinnerian account of language function. The echoic response has been tied to auditory marching in many students diagnosed with developmental disabilities fail to develop echoic responses, and as a result, they do not acquire a vocal verbal behavior repertoire (Chavez-Brown, 2005; Greer & Ross, 2003; Greer & Tsiouri, 2003, 2007). Chavez-Brown (2005) found that a basic auditory match to sample protocol acted to improve or induce echoics. In the present paper, I present two experiments that test the effects of mastery of an *advanced* auditory matching on listener literacy and speaker-as-own listener cusps.

Greer and Ross (2008) suggested that humans acquire speaker-as-own-listener status with the onset of Naming (Greer & Keohane , 2006; Greer & Ross, 2008; Greer & Speckman, 2009), self-talk (Lodhi & Greer, 1989; Greer & Keohane, 2006), and say-do correspondence (Greer & Ross, 2008; Greer & Keohane, 2006; Greer & Speckman, 2009). The speaker and listener functions, that are initially independent, are joined with the onset of these verbal developmental cusps (Barnes-Holmes, Barnes-Homes, & Cullinan, 2001).

Naming is a phenomenon through which individuals acquire the ability to say the words for things (i.e., tacts) and listener responses without direct instruction (Greer, & Ross, 2008). Naming as a higher order class involves arbitrary stimulus

classes and corresponding arbitrary verbal behavior topographies in a bidirectional relationship, where the speaker and listener responses are both learned incidentally (Greer, Stolfi, Chavez-Brown, & Rivera-Valdes, 2005).

Another behavioral developmental cusp that is made possible by the intercept of speaker and listener responses is appropriate self-talk. Self-talk is one of the most important prerequisites for speaker listener exchanges with others or speaker-as-own-listener status (Lohdi & Greer, 1989). Lodhi and Greer (1989) found that young children act in the role of both speaker and listener and emit conversational units aloud in a form of self-talk during solitary free play. They found that the children in the experiment emitted conversational units, and rotated between speaker and listener roles with the anthropomorphic toys during solitary free play.

Another of the cusps involving the intercept of the speaker and listener within the skin is say-do correspondence. Individuals with say-do correspondence can respond as a listener to their own verbal behaviors (Baer, Peterson, & Sherman, 1967). Those in this stage can engage in self-talk by emitting both speaker and listener functions. That is, children with a say and do repertoire can direct their own activities with their speaker and listener behaviors. For example, an individual follows his/her own directions such as “First, I do this, and then I do that.” This demonstrates that what the child says corresponds with what he/she does.

Listener literacy, which is the ability to respond accurately to the vocal verbal instructions of others would appear to be foundational to the rotation of the speaker and listener within one’s own skin as well as responding to the speaker behavior of others (Greer & Ross, 2008). Without listener literacy, children may only respond to

the sequential order of instructions, follow visual cues, or repeat their own responses. Listener instruction is a necessary component to developing other verbal repertoires, such as speaker behavior, echoic responses, and social behavior; thus, listener literacy must join speaker responses in order for the individual to be truly verbal (Chavez-Brown, 2005; Greer, Chavez-Brown, Nirgudkar, Stolfi, & Rivera-Vales, 2005) .

The science of verbal behavior has identified new phenomena and correspondingly new terms for those phenomena. An understanding of these terms and the phenomena they describe is necessary in order for the reader to understand the purpose of the present studies Therefore, I provide definitions of terminologies associated with Skinner's verbal behavior theory and contemporary research extensions of that theory with particualr reference to the verbal behavior development theory (Greer & Keohane, 2006; Greer & Longano, 2010; Greer & Ross, 2008; Greer & Speckman, 2009).

Definition of Terms

1. Auditory Match-to-Sample Instruction

Auditory match-to-sample (MTS) instruction is implemented by providing the reinforcement for a targeted response if the target auditory stimulus is same as the comparison auditory stimulus during a match-to-sample procedure (Chavez-Brown, 2005). The auditory stimuli may involve a progression involving the mastery of MTS responses to sounds, words, and phrases. During auditory match-to-sample instructions, the students are required to match auditory stimuli when presented with a correct match and an incorrect match or non-exemplar.

2. Comprehensive Application of Behavior Analysis to Schooling (CABAS®)

CABAS® is comprehensive in that behavior analytic strategies and tactics are applied to all parties involved in the school process - students, teachers, supervisors, parents and all curricula (Greer, 2002). It is comprehensive in that the substantive findings from individual studies in the literature and packages using the principles of the science (e.g., Precision Teaching, Personalized System of Instruction, Programmed Instruction, Direct Instruction, verbal behavior, Teaching as Applied Behavior Analysis) are incorporated. The measurement of student, teacher, and supervisor responses occurs on a continuous basis for all curricula. The model measures the behaviors of the teachers and supervisors as well as of the students. It is a cybernetic system based on a thoroughgoing operant paradigm evolved "within the constraints and opportunities engendered in the daily operation of school." (Greer & Ross, 2008, pp. 276)

3. Conversational Unit

Skinner (1957) referred to the speaker and listener rotation or turn taking between individuals as verbal episodes. A conversational unit is defined as a verbal relation comprised of interlocking intraverbals between at least two people during which each person functions and is reinforced as both a listener and a speaker in a rotated episode (Greer & Keohane, 2006; Greer & Ross, 2008; Lodhi & Greer, 1989). For example, a speaker, Student 1, said to Student 2, "What is the weather like today?"; a listener, Student 2, responded as a speaker to a listener, Student 1, "It is sunny, now. But it will be rainy later."; and then a listener, Student 1 responded as a speaker to a listener, Student 1, "Ok. Thanks."

4. Conditioning

The conditioning principle was initially established by Pavlov (1897). In higher order classical conditioning, a conditioned or unconditioned stimulus, which has eliciting properties, such as a food, is paired with a neutral stimulus, such as a bell sound. The second-order conditioning is a form of learning in which neutral stimuli are first paired with eliciting stimuli, and then those stimuli are used as a basis for learning about other neutral stimuli. For example, books which are already paired with reinforcement (e.g., snacks) would be used to condition letters and words as reinforcement (Catania, 2008).

5. Cusps

Rosales-Ruiz and Baer (1997) defined behavioral cusps to describe changes in person-environment interactions that enable multiple new interactions. According to Rosaliz-Ruiz and Baer (1997), a cusp is defined as a change in person-environment interactions that enables multiple new interactions. Cusps are also behaviors that have significant and far-reaching implications for further developmental stages (Greer & Speckman, 2009). If developmental cusps are not present, it is not possible or extremely hard to learn certain repertoires or a range of repertoires (e.g., curricular objectives) (Rosales-Ruiz & Baer, 1996). However, once new developmental cusps are acquired, their acquisition permits the learning of classes of operants, which allows one to progress. Cusps allow organisms to expand their learning to more complex development. Recent research has extended the notion of cusps to include the acquisition of new reinforcers (Greer & Singer-Dudek, 2008)

6. Echoic Verbal Operant

The echoic is defined as a verbal operant during which a speaker emits a point-by-point corresponding vocal response to the vocal stimulus of another person (Skinner, 1957). For example, if a parent presents a toy while saying "toy" and the child then says "toy" in order to obtain the toy, this is an example of an echoic-to-mand response. Echoics are different from parroting since the echoic response has the potential to be reinforced by a listener as a mand and tact (Greer & Ross, 2008). Parroting is the emission of self-reinforcing or automatically reinforcing vocal verbal patterns. Echoics differ from imitation in that vocal imitation is a misnomer from the perspective of verbal behavior since what is duplicated I the echoic is not viewable.

7. Emergent Behavior

An emergent behavior is a behavior that comes into existence when it was not directly taught (Speckman & Greer, 2009). For example, the emergence of Naming means that untaught tact and intraverbal responses emerged through a certain intervention (e.g., Multiple Exemplar Instruction, Intensive Tact Instruction, stimulus-stimulus pairings). The capability did not exist before the implementation of the intervention.

8. Higher Order Operant

Higher order operants are defined as overarching operant classes which include other operant classes that can themselves function as operants, as when generalized imitation includes all of the component imitation responses that could be separately reinforced (i.e., generalized imitation). Higher order operants are also developmental cusps.

9. Intensive Tact Instruction

Intensive tact instruction is oftentimes implemented to expand speaker repertoires, which involves teaching tact vocal operants (Pistoljevic & Greer, 2006). Intensive Tact requires the presence of social reinforcement as a generalized reinforcer for tact responses. In Intensive Tact Instruction, learning 100 tact learn units across five academic curriculum categories (e.g., animals, community helpers, monuments, foods, and flowers), is delivered throughout the day. Prior to the start of intensive tact instruction, a mean number of learn units of the student is determined. Tact learn units throughout the day are increased without decreasing other types of learn units, and they are interspersed between learn units for other instructional programs. Four or five instructional categories (e.g., animal, monument, instrument, flower, and community helper) of stimuli are used during instruction. When a category is mastered, it is removed from rotation and the other sets are repeated to supplement 100 tact learn units presentations (Greer & Du, 2010).

10. Intraverbal Operant

An intraverbal operant is a verbal operant controlled by other verbal antecedents (e.g., "How are you?") and may occur in individuals' conversation with other individuals (Greer & Ross, 2008). An intraverbal operant includes verbal behavior which controls other verbal behavior emitted by the same individual. Counting, emitting verses of a memorized poem, and praying may be intraverbal operants. Each of these could also have another function. For example, praying may act as a "magic" mand, and a poem may function as either mand or tact to one's significant other. However, responding to "How are you?" with "fine" is an example

of an intraverbal tact, while responding with "I am not feeling well" may be an intraverbal tact. The function determines whether the response is an intraverbal alone or an intraverbal tact.

11. Joint Stimulus Control

Joint stimulus control occurs when the effects of two different discriminative stimuli (S^d) which function to jointly obtain stimulus control over the common response topography (Lowenkron, 1998). For example, a printed word, "apple" and a picture of an apple would control a common vocal response "Apple." Greer and Ross (2008) also described that a single stimulus may control two or more topographically different behaviors as joint stimulus control. For example, when joint stimulus control is present, a word for spelling would be emitted in a written form (e.g., "a-p-p-l-e") and written form (e.g., writing apple). Thus, the term may refer to two or more responses controlled by one or more stimuli that evoke multiple responses.

12. Learn Unit

The learn unit is "a three term contingency for the student and two or more three term contingencies for the teacher in which the responses of the student occasion a reinforcement or correction operation from a teacher or teaching device." (Greer, 2002, pp. 313) The learn unit is a basic measure of a teaching (Albers & Greer, 1991; Greer, 2002; Greer & McDonough, 1999; Emurian, Wang, & Durham, 2000; Selinske, Greer, & Lodhi, 1991). Moreover, learn units are instructional presentations by a teacher, and then the learner participant as an opportunity to respond. The interlocking three-term contingencies of the teacher and the student are

a learn unit which is a predictor of learning either in written and delayed forms or in vocal and immediate forms. For example, teacher's vocal question or holding up pictures without a vocal question which is under teacher's control, a student's behavior (response), and the consequence (teacher's response to the student: correction for an incorrect response and reinforcement for a correct response) is one learn unit. These interactions predict whether student behavior will be controlled by particular stimuli and setting events. In order for a learn unit to happen, the teacher must respond in certain ways to the presentation of the student S^d and to the resulting behavior or its absence from the student.

13. Listener

Listeners are verbally governed by others as they respond to verbal topographies (Greer & Ross, 2008). That is they can responds to vowel consonant speech sounds of others. Humans with basic listener literacy can comply with instructions and avoid injurious consequences, for example. A pre-listener is initially entirely dependent on others. However, listeners, with a relevant observing response repertoire and basic listener literacy become developmentally more independent (Keohane, Pereira-Delgado, & Greer, 2009).

14. Listener Emersion

Listener immersion is a tested protocol that is implemented to induce basic listener literacy (Greer & Ross, 2008; Greer & Keohane, 2006). In the listener emersion protocol, the student is required to follow vocal directions (i.e., vowel-consonant relations) quickly without error. sixteen target commands and 4 nonsense commands are determined. Each instructional set involves four "true" responses

previously mastered by the student, and one nonsense command (e.g., "blah, blah, blah"). Each set is taught as a separate program and instructional session. Whereas correct responses are reinforced by preferred items and praises, errors (i.e., responding to nonsense command) are ignored by looking away and pausing. This procedure continues until the student meets criteria for accuracy (i.e., two successive 20-lean unit sessions with 90% or more accuracy) and rate (i.e., 30 responses in one minute or one response every 2 seconds without errors) of responding.

15. Listener Literacy

Listener literacy is defined as the ability to respond fluently and discriminatively to the auditory properties of speech (Greer, Chavez-Brown, Nirgudkar, Stolfi, Rivera-Valdes, 2005; Greer & Ross, 2008). Listener emersion is implemented to develop vowel-consonant control for listener responses. It is related to the development of language as early phonemic recognition. But additional reinforcement experiences are required for the phonemes in words to come to control responses by the listener.

16. Listener, Speaker, or Writer Immersion

Immersion is the state of being deeply engaged in instruction based on extensive exposure to environments or conditions that are arranged to increase or improve the verbal behavioral operants which already exist in the repertoire. For example, speaker immersion is implemented to increase the emission of mands which are present in student's repertoire, but not emitted frequently (Ross, 1995; Ross, Nuzzolo, Stolfi, & Natarelli, 2006; Greer & Ross, 2004).

17. Mand Verbal Operant

A mand may be defined as a verbal operant in which the response is reinforced by a characteristic consequence and is therefore under the functional control of relevant conditions of deprivation or aversive stimulation (Greer & Ross, 2008). The term "mand" is derived from the term of "demand" (Skinner, 1957). Mands can occur in the form of spoken words, gestures, written words, or sign language. When a verbal antecedent is present, they are impure mands (e.g., "What do you want?" "Pretzels"); when there are no verbal antecedents, they are pure mands. The reinforcer is specified by the mand.

18. Match to Sample

Matching-to-sample (MTS) refers to a contextual discrimination in which a targeted matching response is reinforced if the comparison stimulus is the same as the sample stimulus (Donahoe & Palmer, 2004).

19. Multiple Exemplar Instruction

Multiple Exemplar Instruction (MEI) involves bringing responses that were initially independent under joint stimulus control (Felician, 2006; Fiorile & Greer, 2007; Gilic, 2005; Greer & Longano, 2010; Greer, Stolfi, Chavez-Brown, & Rivera-Valdez, 2005; Greer, Stolfi, & Pistoljevic, 2007; Speckman-Collins, Lee Park, & Greer, 2007). In this procedure, different responses to a single stimulus (e.g., writing, spelling, and textually responding to a single word) are rotated to induce a student's capability of learning multiple responses to a single stimulus from instruction in only one response form. To teach the Naming capability, for example, MEI with training sets rotating across speaker and listener responses can be implemented to combine

listener responses with the speaker responses for novel stimuli (i.e., joint stimulus control is developed across the speaker and listener repertoires).

20. Naming

Naming is a higher-order class that involves (1) arbitrary or non-arbitrary stimulus classes or stimuli, (2) corresponding arbitrary verbal topographies in a bidirectional relationship, and (3) the capability to learn the names of things incidentally (Horne & Lowe, 1996; Greer, Stolfi, Chavez-Brow, & Rivera-Valdes, 2005). Moreover, the Naming capability is a circular relation of the joining and interlocking of listener and speaker behavior. For example, a child sees an object such as a car, she/he tacts "car" and listens to her own vocal tact. According to Greer and Ross (2008), Naming is a phenomenon through which individuals acquire tacts and listener responses without direct instruction. For example, the teacher has the child match visually the color red with the color red while saying the word, "red." After the matching experience while the child is listening to the antecedent, the child can say the word or tact the color red as a pure tact or as an intraverbal tact. The child has the speaker component of Naming. If the child has the listener component of Naming, the child responds as a listener by pointing to or looking at the red object when the color red is said by another after the matching experience.

21. Parroting

Parroting (Skinner, 1957) is a behavior that repeats the vocal antecedents and includes self-reinforcing or automatically reinforcing vocal verbal patterns. When the vocal verbal patterns match sounds in a child's environment, he/she is reinforced by the correspondence of the vocal pattern he/she emits with those heard. That is,

parroting is essentially an early production response during which vocal sounds are emitted because they are automatically reinforcing to the producer and have no verbal functions. Eventually, these speech sounds may develop into echoics leading to mands, tacts, or other primary speaker operants allowing speakers to gain the capability of echoing others. Parroting is not a speaker operant such as an echoic operant since parroting itself does not have functional effect for the speaker relative to a listener (Barnes-Holmes, Barnes-Holmes, Cullinan, 2001).

22. Probes

A probe includes a procedure that introduces a condition or stimulus to determine the variables controlling it (Catania, 2008). **"**Probes are measures of untaught, relations, or tests of collateral relations, generalized stimulus control, or other operants or higher order operants that either emerge or are brought about as a function of certain experiences." (Greer & Ross, 2008, p. 298)

23. Repertoire

A repertoire is a class or category of operants that an organism has learned and is likely to be emitted in the presence of learned setting events and antecedents (Greer & Ross, 2008). Catania (2007) defined a repertoire as a set of the behaviors which an organism can emit.

24. Self-Talk

Conversational units also involve appropriate fantasy self-talk in which the roles of the speaker and listener occur within the skin of a single individual and are initially overt in young children (Greer & Ross, 2008). Self-talk may include tacts,

mands, intraverbals as well as verbal episodes that meet the criterion for conversational units and sequelics.

25. Say-Do Correspondence

Individuals with say-do correspondence can respond as a listener to their own verbal behaviors (Greer, & Speckman, 2009). That is, an individual who follows the directions of himself or herself has say-do correspondence. For example, an individual follows his/her own directions such as "First, I do this, and then I do that." This correspondence suggests that the listener's and speaker's behaviors are joined (Greer & Ross, 2008).

26. Tact Verbal Operant

A tact is a verbal operant that makes contact with the environment or identifies components of the environment resulting in the delivery of a generalized reinforcer by the listener or reader (Greer & Ross, 2008). However, a tact can be reinforced and maintained by social reinforcement of a social nature. The term "tact" is derived from the term "contact." Pure tacts are governed directly by the nonverbal antecedent conditions; if there is a verbal antecedent, it is an intraverbal. The item contacted is reinforced by a generalized or nonspecific reinforcer for the tact.

27. Verbal behavior

Verbal behavior refers to a behavior reinforced through the mediation of other persons who deliver reinforcement. That is, verbal behavior is a study of function of human language (Skinner, 1957). For example, extensive written languages, sign languages, and languages in which the speaker stimulates the skin of the listener would be verbal behaviors.

28. Verbal Behavior Developmental Capability

A capability is a verbal developmental cusp that allows children to learn in new ways they could not before (Greer & Speckman, 2009). A cusp brings the developing organism into contact with other cusps crucial to further, more complex, or more refined development (Greer & Longano, 2010). Verbal capabilities are the cusps that allow individuals to learn new repertoires, by observing consequences received by others and in many cases without direct instruction. Inducing a given capability allows the emission of new verbal responses without direct instruction because the untaught function has become part of a higher-order operant or class. For example, the children who do not have Naming cannot acquire speaker or listener repertoires without direct instruction. Generalized imitation, Naming, and observational learning have been identified as verbal developmental capabilities from empirical research in experimental studies (Ross, & Greer, 2003; Tsiouri, & Greer, 2007; Fiorile & Greer, 2007; Gilic, 2005; Greer, Stolfi, Chavez-Brown, & Rivera-Valdes, 2005; Greer & Singer-Dudek, 2008; Greer, Singer-Dudek, & Gautreaux, 2008).

Verbal Behavior Theory

Skinner (1957) studied proposed a theory human language in terms of that focused on its function. His verbal behavior theory more effectively explained focused on that aspect of language concerned with the effects of a speaker's behavior on the listener. The function of human language was an aspect of language study that linguists missed. When Skinner wrote Verbal Behavior (1957), verbal behavior was a theory to be dictated by the task itself. Little in the way of specific experimental

studies had been conducted with respect to the individual speaker or listener. For the past five decades, however, research and other theories modified and supplemented Skinner's verbal behavior theory. Therefore, this paper will address the definition of verbal behavior/verbal operants and how verbal behavior theory was modified and supplemented in terms of Naming (Horne and Lowe, 1996; Greer & Speckman, 2009) and the verbal behavior developmental theory (Greer & Ross, 2008; Greer & Speckman, 2009).

Forms of Verbal Behaviors

Any movement affecting other organisms' behaviors may be verbal (Skinner, 1957). That is, extensive written languages, sign languages, and languages in which the speaker affects listener's behaviors would be verbal behaviors. Even audible behavior (e.g., clapping the hands for a servant, or blowing a bugle) are forms of behavior that may be verbal.

Types of Verbal Operants

Skinner identified six verbal operants as the echoic, mand, tact, intraverbal, autoclitic, and textual responding (Skinner, 1957). An echoic is a verbal operant that has a point-to-point correspondence between the sound of the stimulus and the sound of the response. A mand is a verbal operant that specifies its reinforcer under relevant motivational conditions, which are deprivation or alleviation of disconcerting events. Mands can occur in the form of spoken words, gestures, written words, or sign language. A tact is a verbal operant that makes contact with the environment or identifies components, and the result is the delivery of a generalized reinforcer by the listener or reader (Skinner, 1957; Greer & Ross, 2008). The item contacted is

reinforced by a generalized or nonspecific reinforcement for the tact. An intraverbal is a verbal operant that is controlled by a verbal antecedent as in greetings. Intraverbals may occur between individuals (e.g., "How are you?" "I'm fine."), or they may be composed of verbal behavior controlling verbal behavior for the same individual, such as counting, saying the verses of a memorized poem, reciting the pledge of allegiance, and praying, or singing. An autoclitic is a verbal operant that functions to modify, specify, qualify, quantify, affirm, or negate the effect of other verbal operants such as mand and tact. The autoclitics function to affect the audience or listener by increasing the reinforcement possibilities for the speaker or to decrease the likelihood that an audience will punish a statement (e.g., please).

Skinner described textual behavior as a verbal operant under the control of printed, verbal stimuli (Greer and Ross, 2008). Textual responding is a reader function during which the consonant-vowel phonemes associated with a printed stimulus evoke a speaker's responses. It is only on a component of reading.

Verbal Behavior Development Theory

Greer and Ross (2008) drew on contemporary findings related to Skinner's verbal behavior theory and research on how it is acquired ontogenetically in their verbal behavior development theory. They identified the verbal behavior development capabilities and cusps identified in research expanding on work by Rosales-Ruiz & Baer (1997). Behavioral developmental cusps are behaviors that have significant and far-reaching implications for further developmental stages. Cusps may also include newly established reinforcers also. If developmental cusps (capabilities or stages) are not present, it is not possible or extremely hard to learn certain repertoires or a rage of

verbal repertoires. Cusps include: (a) teacher presence results in instructional control over a child, (b) conditioned reinforcement for voices and faces, (c) conditioned reinforcement for 3D object/visual stimuli on desktop, (d) capacity for sameness across senses, (e) visual MTS for 2D and 3D or generalized visual identity matching, (f) generalized imitation, basic listener literacy (coming to respond to vowel consonant arrangements emitted by speakers), (g) auditory matching of words heard, (h) echoic-to-mand/tact, independent mands, (i) transformation of establishing operations, (j) full Naming, (k) say-do correspondence, self-talk, (l) book stimuli conditioned reinforcement for observing, and (m) observational learning. Capabilities that are cusps include: generalized imitation, Naming, and observational learning. According to Greer and Ross (2008), these are the currently identified verbal capabilities and cusps.

Development of Skinner's Theory

When Skinner wrote Verbal Behavior (1957), a few experiments had been conducted with respect to the individual speaker or listener (Greer & Keohane, 2006; Greer & Ross, 2008; Greer & Speckman, 2009). His verbal behavior theory was modified in terms of the emergence of untaught novel behaviors. Skinner's verbal behavior theory was supplemented and supported by other following research in verbal behavior and by extension terms of the verbal behavior developmental theory.

Emergence of Untaught Verbal Behaviors

Incidental Learning in Linguistics

In linguistics, studies also investigated incidental learning of human's language during the past fifty years. It is apparent that humans cannot learn such

large quantities of new vocabularies only by intentional learning activities in which they memorize word forms and their correspondent meanings (Hulstijn, Hollander, & Greidanus, 1996). Individuals pick up and comprehend many new words through listening and reading. This process is usually considered as the incidental learning of languages.

Incidental learning is defined as learning which occurs in the absence of a specific intent to remember (Jenkins, 1933). Chomsky (1975) argued that language acquisition is a subconscious process. That is, language acquisition occurs informally in the context of functional language use (Neuman & Koskinen, 1992). Hulstijn (1989) and Schmidt (1994) defined incidental learning as the accidental learning of information without the intention of remembering that information. Incidental learning of language is also identified as vocabulary growth by learning or comprehension of the relations between the meanings of previously unknown words and word forms through reading and listening (Hulstijn, Hollander, & Greidanus, 1996).

In verbal behavior analysis, however, incidental learning of language is determined by identifying functional relations between verbal behavior functions and the environment (Knapp, 1990). Through incidental learning, an individual acquires verbal operants in a listener function to a stimulus in his/her environment, and then he/she also is able to emit verbal operants in a speaker function (e.g., tact, intraverbal) to the same stimulus in the environment without direct instruction. The focus of research in verbal behavior on incidental language seeks to identify the ontogenetic

environmental conditions that control the onset and expansion of language functions that are attributed to incidental learning.

Emergence of Verbal Behaviors without Direct Instruction

Skinner (1957) argued that speaker and listener behaviors are learned separately by the environmental contingencies that follow the behavior. He also stated that speaker and listener behaviors are joined at some point in verbal development. However, the emergence of untaught verbal behaviors without direct contingencies was not fully explained by Skinner (1957) although he referred to them, because the relevant research was not available at the time. Subsequent research has supplied some answers to how emergent language comes about and raised other questions. However, to explain verbal behavior development, the explanation of emergent behaviors without direct reinforcement contingencies is necessary. Findings in research on stimulus equivalence could not be explained easily by reinforcement contingencies (Sidman 1971). For a decade or more after Sidman (1971) identified stimulus equivalence, theories of the source of stimulus equivalence were proposed Sidman (1971), relational frame theory (Barnes-Holmes, Barnes-Holmes, & Cullinan, 2000), Naming theory (Horne & Lowe, 1996), more recently the verbal behavior developmental theory (Greer & Keohane, 2006; Greer & Ross, 2008; Greer & Speckman, 2009). These theories and related research may explain the sources of stimulus equivalence and emergent behaviors.

Stimulus Equivalence

Sidman (1971) first identified emergent behavior through his studies of stimulus equivalence. Sidman (1986) proposed that stimulus equivalence is the determining variable that accounts for both speaker and listener behavior. He surmised that it was a genetically given human capability that was not reducible. RFT expanded the range of derived relations and provided evidence of its ontogenetic origins and related theoretical extensions. Most typically developing children acquire novel verbal behaviors within contexts in a verbal community. Stimulus equivalence theory could not clearly explain the basis how the acquisition of novel verbal behavior occurs. Naming theory and verbal behavior developmental theory identified ontogenetic sources for emergent verbal development (Greer & Longano, 2010; Horne & Lowe, 1996). Stimulus equivalence may refer to "a phenomenon in which each stimulus in a given group evokes a verbal or nonverbal response" (Sidman, 1994, pp. 416–417). For example, human categories often consist of written words, spoken words, and their referent objects (real or pictorial). Stimulus equivalence describes groups of stimuli that become interrelated in specific and verifiable ways. Stimulus equivalence involves three distinct features, reflexivity, symmetry, and transivity (Sidman, 1990; Sidman & Tailby, 1982; Place, 1995/6). Reflexivity is the relation in which a stimulus is conditionally related to itself (i.e., A is related to A). Symmetry is shown if it is demonstrated that each of the relations in original training is bidirectional. For example, if A is related to B, B is related to A. Transitivity is the emergent forward relation (i.e., if A is related to B, and B is related to C, then C is related to A).

Matching-to-Sample Procedure

Stimulus equivalence classes typically are established using match-to-sample (MTS) procedures in which conditional discriminations are arranged among arbitrarily assigned sets of stimuli (Sidman, 1971; 1973; 1994; Lowe & Horne, 1996). The match-to-sample procedure involved matching across auditory (e.g., hearing a word) and visual stimuli (e.g., printed word or corresponding picture). Each matching condition was taught directly and separately. After the match-to-sample procedure, equivalence relations (i.e., untaught behavioral relations) for novel stimuli emerged without direct contingencies (Sidman, 1971). These untrained behavioral relations were called equivalence relations.

Functional Equivalence

Functional stimulus classes are sets of discriminative stimuli that control the same behavior (Kastak, Schusterman, & Kastak, 2001). When stimuli *evoke* the same responses and they are functionally interchangeable, the stimuli have functional equivalence. Sidman (1971; 1973; 1994) also argued that the different stimuli (e.g., picture of a car and the printed word CAR) may be discriminative for a common response (saying "car"). This relation is a functional equivalence (Sidman, 1986). The functional equivalence between auditory and visual stimuli is the essential component for the development of reading comprehension. For example, after a child learns to match auditory words (e.g., “Car”) to printed stimuli (e.g., CAR) she/he can match the printed words to the pictures. For example, if the word ‘‘car’’ and the new word ‘‘automobile’’ are spoken and reinforced in the presence of an actual car, and then, without direct training, the word ‘‘automobile’’ is spoken in the presence of a picture

of a car, the actual car and picture of a car constitute a functional stimulus classes (Catania, 2008). Functional equivalence has provided one theoretical basis to address the relation between verbal behavior and the acquisition of equivalence classes and novel behavior (Sidman, 1971; Wirth & Chase, 2002).

Relational Frame Theory (RFT)

Sidman and Tailby (1982) argued that novel (i.e., untaught) relations comprised of the relations of reflexivity, symmetry, and transivity. Reflexivity is the relation in which a stimulus is conditionally related to itself (i.e., A is related to A). Symmetry is shown if it is demonstrated that each of the relations in original training is bidirectional. For example, if A is related to B, B is related to A. Transitivity is the emergent forward relation (i.e., if A is related to B, and B is related to C, then C is related to A). In Relational Frame Theory (RFT), these novel relations are referred to as mutually entailed and combinatorally entailed relations (Hayes et al., 2001). Hayes and Hayes (1989) argued that a relational frame is a particular pattern of contextually controlled and arbitrarily applicable relational responding involving mutual entailment, combinatorial entailment, and the transformation of stimulus functions. Relational frames are a type of a generalized operant (Hayes & Wilson, 1993). In relational frames, the function of different stimuli is transformed. If a relational frame involves Stimuli A and B, and Stimulus A evoked a behavioral function, the stimulus function of B will be transformed in a relevant context with this relation (Barnes, Healy, & Hayes, 2000).

Multiple Exemplar Experience

According to Hayes (1992) and Hayes, Barnes-Holmes, and Roche (2001), relational frames are established through instructional history of bidirectional responding across multiple exemplar experiences in a verbal community, and individuals acquire the frames with a variety of exemplars of the specific frames as higher order operants (Barnes & Holmes, 1991; Barnes, Healy, & Hayes, 2000; Barnes-Holmes & Barnes-Holmes, 2000; Barnes, Holmes, Barnes-Holmes, Roche, & Smeet, 2001). If individuals do not acquire the relational frames through experience in their environments, they might be able to acquire these frames through instruction in which the core features of the frames are presented within a variety of exemplars. Hayes and Wilson (1993) argued that arbitrarily applicable relational responding was the critical feature of verbal behavior. They stated that relational frames are a type of a generalized operant. In relational frames, the function of different stimuli is transferred to other verbal behaviors. Speaker's and listener's behavior are interlocked in the relational frames. A speaker was speaking with meaning, and a listener was listening with understanding (Hayes & Hayes, 1989). According to Hayes and Wilson (1993), the verbal communication between a listener and speaker is a set of conventional, contextually controlled relational frames and a set of conventional stimulus relations established through these frames.

Naming Theory

Horne and Lowe (1996) also argued that Naming includes stimulus equivalence. Naming Theory has focused on the contingencies that generate Naming as the coordination of listener and speaker repertoires that is said to be necessary for

equivalence to emerge (Horne & Lowe, 1996; Luciano, Becerra, & Valverde, 2007). Home and Lowe (1996) stated that "Naming is a higher order bi-directional behavioral relation that combines conventional speaker and listener functions." (p. 209) Naming involves the establishment of bi-directional or closed loop relations between a class of stimuli and the speaker-listener behavior occasioned by the stimuli. Thus, a Naming capability is a circular relation of the joining and interlocking of listener and speaker behavior. For example, a child sees an object such as a car, she tacts "car" and listens to her own vocal tact. Then, this listening may occasion her looking at any other cars or pictures of cars in that listener behavior class. Verbal behavior studies that have followed defined Naming in terms of bi-directional relations between a class of stimuli and the speaker-listener behavior (Horne & Lowe, 1996; Horne, Lowe, & Randle, 2004; Lowe & Horne, 1996; Lowe, Horne, Harris, & Randle, 2002; Lowe, Horne, & Hughs, 2005). They demonstrated that the component parts of Naming allowed the child to respond as a listener and/or a speaker without direct instruction. Naming includes the acquisition of words for things as a speaker and listener from incidental experiences, although the incidental focus was not the most conspicuous emphasis of Horne and Lowe's theory (1996). In the verbal behavior developmental theory, however, research focuses on the acquisition of words for things from incidental experiences and the sources for this capability in the ontogenetic history of the individual (Greer & Ross, 2008; Greer & Speckman, 2009; Greer & Longano, 2010).

Naming as Verbal Capability

Greer and Keohane (2006), Greer and Longano (2010), Greer and Ross (2008), and Greer and Speckman (2009) identified Naming as the verbal capability of Skinner (1957) described as speaker-as-own-listener. Catania (2002) suggested that "Naming is a higher-order class that involves arbitrary stimulus classes and corresponding arbitrary verbal topographies in a bidirectional relationship" (p. 255). Once this developmental stage, Naming, emerges, the initially separate listener and speaker repertoires are joined and interlocked. Children with Naming can acquire names for things as a speaker and listener from incidental experiences that do not involve direct instruction. The interlocked listener and speaker repertoires are also demonstrated in self-talk, conversational units and say-do correspondence. Thus, the child engages in a speaker-listener exchange and learns other novel verbal operants.

According to Greer and Speckman (2009), Naming is a verbal behavior developmental capability that allows the acquisition of words for things as a speaker and listener from incidental experiences. Naming consists of two components: the listener component and speaker component. Once an individual acquires the listener component of Naming, he/she can respond to the stimulus as a listener (e.g., pointing) by hearing the name of the same stimulus without direct contingencies. Once an individual acquires the speaker component of Naming, he/she can respond to the stimulus as a speaker (e.g., tact and intraverbal) by hearing the name of a stimulus without direct contingencies. Thus, Naming allows the individual to respond to a same stimulus as both listener and speaker as a function of incidental experience since speaker and listener functions are joined in Naming.

Naming has been induced through (1) Multiple Exemplar Instruction (Fiorile, 2006; Greer, Stolfi, Chavez-Brown, & Rivera-Valdes, 2005; Helou-Caré, 2008), (2) Auditory Matching Instruction for the listener half only of Naming (Lee Park, 2005; Speckman-Collins, Lee Park, & Greer, 2007) , (3) Intensive Tact Instruction (Greer, Stolfi, & Pistoljevic, 2007; Pistoljevic, 2008), and (4) stimulus-stimulus pairing (Longano, 2008).

Multiple Exemplar Instruction

Multiple Exemplar Instruction involves the rotation of match while hearing the tact, point-to, tact and intraverbal responses to the same set of stimuli that can result in untaught responses to novel stimuli. A lot of research demonstrated that MEI results in Naming in which untaught responses emerged from a single stimulus presentation without direct instruction (Feliciano, 2006; Fiorile & Greer, 2007; Gilic, 2005; Greer, Stolfi, Chavez-Brown, & Rivera-Valdez, 2005; Greer, Stolfi, & Pistoljevic, 2007; Speckman-Collins, Lee Park, & Greer, 2007). Skinner (1957) identified these sophisticated types of verbal behavior as behavior under multiple controls.

Greer, Stolfi, Chavez-Brown, and Rivera-Valdez, (2005) conducted a study with three preschool-aged participants. Multiple exemplar instruction was utilized to transform stimulus functions across listener responses and speaker responses. Greer et al. (2005) presented the three sets of stimuli across four repertoires: matching while hearing the word for the object, point to as a indication of the listener response, pure tact, and intraverbal responses as incidences of speaker behavior. Participants received 80 learn units in a complete multiple exemplar session for a set of stimuli.

The results demonstrated that untaught speaker responses increased from 60% to 85% for two participants and from 40% to 70% for one participant.

Greer et al. (2007 replicated the Greer et al. (2005) with eight preschoolers with ASD and in addition isolated MEI training from similar training using massed instruction for each response separately. This experimental and control group with nested multiple probe designs showed that the rotation across response types was key to the emergence of Naming.

Fiorile and Greer (2007) conducted two experiments to test the effects of multiple exemplar instruction on teaching the listener to speaker component of Naming. The results of this study showed MEI procedures lead to the transfer of stimulus function from visual to listener responding, and to speaker behavior.

Gilic and Greer (2009) conducted two experiments to investigate how the bidirectional components of Naming affect the acquisition of Naming in typical two-year old participants. Data showed the experience of multiple exemplar instruction resulted in the transformation of stimulus function across listener and speaker functions and the incidental acquisition of names for things as a speaker and listener. The responses that participants did not emit following listener instruction were emitted as a result of the multiple exemplar instruction with an untaught set of a set of novel stimuli. This study also reported that out of 17 typically developing 2 and 3-year old children from a nursery school, the nine 3-year olds had Naming and the eight 2-year olds did not. The eight two year olds acquired Naming as described above as a function of MEI.

Feliciano (2006) conducted two experiments to test the effects of multiple exemplar instruction (MEI) on the emergence of the listener component of Naming with six participants with severe language delays. In this MEI intervention, the experimenter rotated learn unit presentations across matching and pointing while the participant was heard the words for the stimuli spoken (i.e., the tacts for the stimuli). The participant was heard the words as he/she matched or pointed the stimuli, respectively in the training sets. Prior to and after the mastery of MEI, unconsequated probes were conducted to test for the listener half of Naming. In both experiments, results showed that MEI induced the listener half of Naming for all six participants.

Helou-Caré (2008) conducted two experiments to test the effects of the emergence of Naming on reading comprehension with middle school age participants diagnosed with emotional disabilities, who lacked Naming. After baseline match instruction was conducted in which the participants were required to match the target stimuli, a pre-probe was conducted to test the emergence of untaught responses (i.e., point-to, tact, and intraverbal) on the same 2D and 3D stimuli. Following the probe sessions on untaught responses, Multiple Exemplar Instruction was then implemented with 3D stimuli in which the participants were required to match, point-to, tact, and intraverbally label the stimuli. After the participant achieved the predetermined criterion, he/she was probed on the 3D stimuli set that had initially been used in the pre-probe session, as well as a novel set of three-dimensional stimuli. If the participant emitted more than 80% correct untaught responses on the 3D post-probe sessions, then the 2D stimuli set was probed, as well as a novel set of two-dimensional stimuli. Results of Experiment 1 showed that MEI with 3D stimuli

induced all participants' Naming for both 2D and 3D stimuli. Experiment 2 tested the effect of the emergence of Naming on reading comprehension with four middle school age participants. All participants functioned below grade level for reading and math. Experiment 2 systematically replicated the procedures of Experiment 1. However, pre-probes were conducted after initial matching instruction. After initial match sessions for 2D stimuli, the participant was required to emit textual responses to a story and, then probed for the listener (point-to) and speaker (intraverbal) responses to reading comprehension questions. MEI was implemented using 2D stimuli. Post-probes for Naming were conducted as in Experiment 1. Participants' reading comprehension probes followed Naming probes. After the participant achieved Naming through MEI, a novel story was used to test listener and speaker reading comprehension responses. Results showed that Naming for 2D and 3D stimuli emerged as a function of MEI, which supports the findings of Experiment 1. The emergence of Naming also increased participant's reading comprehension responses.

Intensive Tact Instruction

Pistoljevic (2008) in an unpublished dissertation tested the effects of Multiple Exemplar Instruction (MEI) and Intensive Tact Instruction (ITI) on the acquisition of Naming in preschoolers in two experiments. In Experiment 1, the dependent variable in the study was the acquisition of joint stimulus control across the listener and speaker responses for two- and three-dimensional stimuli. After match instruction for the target set of two-dimensional and three-dimensional stimuli, untaught listener and speaker responses were probed for all participants. During intervention sessions, the

Single Exemplar Instruction (SEI) group separately received 20 learn units for matching, pointing, tact, and intraverbal responses which resulted in the total number of 80 learn unit presentations. The Multiple Exemplar Instruction group received 80 learn unit presentations in which all four verbal responses were randomly rotated in 20 learn unit presentations for each verbal response topographies. The stimuli were counterbalanced so that multiple exemplars of the same stimuli were not presented in successive learn units. Participants in the two groups received the same number of learn units with the same stimuli. After the achievement of criterion in a training stimulus set, a post-probe was conducted on the initial two-dimensional and three-dimensional stimuli sets. The results demonstrated that the MEI group acquired Naming; the SEI group did not acquire Naming. This was a direct replication of Greer et al. (2007).

In Experiment 2, Pistoljevic (2008) tested the effects of Intensive Tact Instruction (ITI) on the emergence of the speaker and listener components of Naming and the numbers of vocal tacts emitted in non-instructional settings (Pistoljevic, 2008). During Intensive Tact Instruction (ITI), 100 additional learn units for tacts were presented above the mean number of participant's daily learn units. The results showed that Intensive Tact Instruction (ITI) induced Naming for all participants and increased the numbers of independent vocal tact and mand operants emitted in the non-instructional settings.

Stimulus-Stimulus Pairing

Longano (2008) conducted three experiments to investigate the source of reinforcement for Naming. The first experiment showed that requiring participants to

emit echoics in matching and pointing training sets resulted in Naming for three out of four participants when MEI training had not done so for these participants.

In the second experiment, a stimulus-stimulus pairing procedure was implemented with the participant from Experiment 1 who did not acquire Naming from the echoic training condition. In this study a conditioned visual reinforcer was paired with neutral vocal stimuli. The results of the second experiment showed how the stimulus-stimulus resulted in Naming.

In the third experiment, the experimenter replicated the procedure of the second experiment with the participants who did not have a history of MEI training. The results showed all three participants achieved Naming through a stimulus-stimulus pairing procedure in which either auditory or visual stimuli were conditioned as reinforcers with one of the stimuli that was already a reinforcer for observing responses.

Auditory Match-to-Sample Instruction

Speckman-Collins, Lee Park, and Greer (2007) tested the effects of generalized selection-based auditory match-to-sample (MTS) instruction on the emergence of the listener component of Naming with preschool age participants diagnosed with developmental delays who lacked speaker responses. The participants were selected since they did not have auditory discrimination responses and the listener half of Naming. An auditory MTS instruction was implemented to teach participants to match auditory stimuli. In the auditory MTS instructional sessions, two BigMac® buttons, one with a negative exemplar sound or word and target sound or word and one with the target sound or word were placed in front of the participants

and one sample button was placed in front of the experimenter who was across the table. The experimenter pressed the sample button and 2 exemplars and gave the vocal verbal antecedent "Match." The participant was required to match the target sound by pressing the positive exemplar button. The auditory MTS intervention consisted of (1) matching sound versus no sound, (2) matching sounds versus other sounds as non-exemplars; (3) matching words when nonsense words were used as non-exemplars, (4) matching words with other words as non-exemplars, and (5) matching words with similar phonetic structures. The listener component of Naming was probed prior to/after the auditory MTS instruction. The results indicated that the listener component of Naming progressively emerged as the participants progressed through the auditory matching phases. Speckman-Collins, Lee Park, and Greer (2007) argued the auditory MTS instruction can also potentially provide the reinforcement history to condition auditory stimuli as reinforcers, which can result in the emergence of untaught listener repertoires.

Echoic Repertoires

The echoic operant is a verbal operant function during which a speaker emits a vocal response with point-to-point correspondence to the vocal stimulus of another person when children have history of having the echoic have a verbal function (Greer & Ross, 2008; Skinner, 1957). The echoic repertoire is valuable in language instruction because it can be used to shorten the shaping process (Skinner, 1957). Through an echoic repertoire, a listener becomes a speaker, whose emitted verbal responses are reinforced by listener (Catania, 2007). That is, a minimal echoic repertoire is needed for an individual to acquire other kinds of stimulus control from

other verbal operants. The initial instruction of mands or tacts begins with echoic behavior. This means that the instructor arranges motivational conditions and reinforcers differently when teaching mands and tacts. Moreover, echoics are distinguished from parroting in that the echoic response has the potential to be reinforced by a listener as a mand or tact, while parroting is automatically reinforced (Skinner, 1957).

Parroting

Parroting is the vocal patterns that are self-reinforcing and match the sounds emitted by another individual (Skinner, 1957). The child who is at a pre-verbal speaker developmental stage emits this vocal pattern. According to Greer and Ross (2008), parroting is a prerequisite to emitting echoic behaviors since it is an early level of duplicating. Parroting and echoic behavior are different in terms of their own functions. Since parroting functions as self-reinforcement or automatic reinforcement, it does not affect listener's behaviors. However, echoic behavior results when a child has a history of speaking to control he behavior of a listener who mediates reinforcement for the speaker.

Yoon (1998) and Sundberg et al. (1996) implemented a stimulus-stimulus pairing procedure to pair participant's vocalizations with a reinforcer. They stated that the stimulus-stimulus pairing procedure provided a conditioning reinforcement history to induce parroting and other speaker responses such as echoics.

Auditory Match-to-Sample Instruction to Induce Echoic Repertoires

The discrimination between positive and negative exemplars of words, the capability of auditory match-to-sample (MTS) of words, and generalized auditory

MTS of words resulted in more accurate speaker behavior (Chavez-Brown, 2005; Greer & Ross, 2008). An auditory MTS instruction can be implemented to teach auditory discriminations.

Marion, Vause, Harapiak, Martin, Yu, and Sakko (2003) also tested the predictive validity of three auditory matching tasks. This study compared the correlations between the Assessment of Basic Learning Abilities test (ABLA), two auditory-auditory matching tasks, and the ability to emit three specific verbal operants: echoics, mands and tacts. The results showed that individuals who passed two auditory-auditory matching tasks performed better on the test of three verbal operants than those who failed in those same tests. The participants had less difficulty in echoics than mands and tacts. Therefore, this research showed a correlation between auditory matching responses and echoic repertoires.

Chavez-Brown (2005) conducted two experiments to test the functional effects of the acquisition of a generalized auditory word match-to-sample repertoire on the echoic repertoire. For the auditory matching procedure three Big Mac® buttons were used. Two placed in front of the participant as a positive and negative exemplar and the third provide the sample that the participants matched to. The instructor would press all three buttons for the participant and then repress the sample button and deliver the vocal verbal antecedent "match". The participant was required to match the target sound by pressing the positive exemplar. The auditory matching procedure was effective in improving the echoic behavior for all participants. The participants were required to press BigMac® buttons that produced sounds that were identical to the sounds produced by the experimenter's button. The participants made

progress through levels of instruction including sound vs. no sound, sound vs. white noise, sound vs. sound, non-word vs. word, word vs. word and finally, novel word vs. novel word (generalized auditory matching). The results of Experiment 1 showed that participants who previously lacked an echoic repertoire began emitting vocalizations, partial echoics, and full echoics after the acquisition of an auditory word match-to-sample repertoire. In the same manner, those participants in Experiment 2, whose echoic repertoire was flawed and difficult for the listener to understand, acquired an exact and clear echoic repertoire after the acquisition of an auditory word match-to-sample repertoire. Therefore, the results showed that the acquisition of an auditory MTS repertoire resulted in increased partial and/or full echoic responses for all participants.

Echoic-to-Tact

Echoic behavior is a prerequisite to the development of other speaker behaviors such as tacts and mands (Fiorile & Greer, 2007; Greer & Ross, 2008). The echoic-to-tact instructional procedure is one of the pedagogical tactics from verbal behavior analysis which is framed to establish the tact operants.

Barbera and Kubina (2005) conducted a study to test the effects of using transfer procedures to teach tacts for the participants with autism. They argued that the echoic-to-tact procedure is a transfer procedure to teach tacts. In the study, the experimenter presented the vocal antecedent (e.g., “bird”) along with a nonverbal stimulus (e.g., bird picture). The participant’s correct echoic response (e.g. “bird”) was reinforced. After implementing the previous sequence, the nonverbal stimulus was presented without the vocal antecedent. If the participant emitted a correct tact,

the reinforcing consequence was applied. The results of this study showed that the echoic-to-tact procedure resulted in the successful acquisition of the targeted tacts. However, the tacts were not clear tact since the reinforcement of the tacts were not social.

Listener Literacy

The listener function is a key component in the development of verbal functions (Greer & Ross, 2008). Basic listener literacy consists of hear-do behaviors. Hear-do behavior occurs when other's consonant-vowel combination sounds control listener's responses. For example, a child with basic listener literacy can discriminate different vocal directions (e.g., clap hands and blow kiss) and can emit accurate responses based on the discrimination. Children with developmental disabilities may only respond to the sequence of instruction, follow unrelated visual cues, or repeat their own responses. Listener instruction should be implemented to develop other verbal repertoires such as speaker behavior, echoic responses, and social behavior (Chavez-Brown, 2005). The acquisition of a fluent listener repertoire is also a pre-requisite to acquiring other educational objectives with fewer instructional units (Greer & Keohane, 2006). Listener literacy should be developed before speaker responses can be induced. A tested protocol for inducing basic listener literacy, learning first instances of vowel consonant control of responding as a listener, was identified as listener emersion.

Listener Emersion

The listener emersion protocol is a direct way to induce a listener repertoire. Listener emersion under especially arranged motivating conditions immerses the

student in listener instruction in order to induce the immersion of the basic listener literacy (Greer, Chavez-Brown, Nirgudkar, Stolfi, & Rivera-Valdes, 2005; Greer & Ross, 2008). Greer, et. al. (2005) showed the effects of listener literacy on the rate of acquisition of new operants. They compared the numberss of learn units to meet criterion prior and after listener emersion. A multiple probe design across 8 participants with Autism Spectrum Disorder participants was used. The participants were selected because of the limitation of functional verbal capabilities, and the numbers of learn-units-to- criterion in basic listener programs such as matching, pointing, and instructional control. In the listener emersion protocol, all instruction throughout the day was devoted to teaching the participants to respond solely to vowel-consonant combination vocal directions until they had mastered a sequence of successively more difficult responses. After they mastered the instructions for accuracy, they were placed in the fluency instruction. The results indicated that the numberss of learn units to criterion decreased significantly for all participants across all curricular areas, particularly the curricula related to vocal instruction. Thus, this finding demonstrated the importance of the basic listener literacy capability for effective learning.

Speaker as own Listener

Three types of speaker-as-own-listener behaviors have been indentified by experiments: (1) Naming (Greer & Keohane , 2006; Greer & Ross, 2008; Greer & Speckman, 2009), (2) self-talk (Lodhi & Greer, 1989; Greer & Keohane, 2006), and (3) say-do correspondence (Baer, Blount, Detrich, & Stokes, 1987; Greer & Ross, 2008; Greer & Keohane, 2006; Greer & Speckman, 2009). Lodhi and Greer (1989)

theorized that speaker-as-own-listener conversational units could be identified. They tested the effects of two conditions on the participants' verbal behavior. An anthropomorphic toy condition and a non-anthropomorphic toy condition were evaluated, and dependent variables were verbal behavior units including tacts, mands, autoclitics, intraverbals, and self-conversational units during fantasy play when the child was alone in a play area. The participants were four typically developing female 5-year old kindergartners from upper middle class homes. The results demonstrated that the participants emitted more speaker-as-own-listener conversational units during the anthropomorphic toy condition than during the non-anthropomorphic toy condition. Moreover, data showed that conversational units occurred only in the anthropomorphic, or fantasy play condition. This study demonstrated the speaker-as-own listener with the skin suggested by Skinner (1957). Since the children had not yet acquired the audience control for covertly emitting self-talk they did so overtly allowing the direct observation of speaker-as-own-listener behavior within the skin.

Conditioning Theory

Pavlov studied the digestive system of dogs and became intrigued with his observation that dogs deprived of food began to salivate when one of his assistants walked into the room. He began to investigate this phenomenon and established the principles of classical conditioning. This type of conditioning consists of the presentation of a stimulus or environmental event simultaneously with or closely followed by an eliciting stimulus (Huitt & Hummel, 1997; Donahoe & Palmer, 2004). Skinner renamed this form of learning "respondent conditioning" to distinguish it

from operant conditioning since in this type of learning, one is responding to an environmental antecedent. Respondent conditioning is most often discussed in terms of reflex behaviors or other such automatic responding. Neutral stimuli are paired with eliciting stimuli, and as the neutral stimuli acquire eliciting properties, individuals respond to them with the same automatic or reflex behaviors. Second-order conditioning is a form of learning in which neutral stimuli are first paired with eliciting stimuli, and then those stimuli can function as reinforcers in operant conditioning (Catania, 2008). Donahoe & Palmer (2004) suggested a unified operant respondent principle.

The conditioning procedure is derived from the principle of conditioned reinforcement (Greer, Becker, Saxe, & Mirabella, 1985). A conditioned reinforcement is a stimulus that functions as a reinforcer because of its contingent relation to another conditioned or unconditioned reinforcer. It can be called a secondary reinforcer (Catania, 2008; Donahue & Palmer, 2004). It is distinguished from unconditioned reinforcement that refers to reinforcers that have not required a conditioning process. That is, conditioned reinforcements are acquired as a function of each individual's unique experience with his/her environment. Neutral stimuli can also acquire reinforcing properties as a function of observation (Greer & Singer-Dudek, 2008). Conditioned reinforcers are items that acquire reinforcing properties because they are paired with other items or events that have reinforcing properties either incidentally or through systematic instruction (Greer & Ross, 2008). For example, when books are paired with edibles and praise, the books become reinforcers for observing Tsai & Greer, 2006).

In several recent studies, a systematic stimulus-stimulus pairing procedure was implemented (Greer, Pistoljevic, Cahill, & Du, 2011; Greer & Ross, 2008; Keohane, Luke, & Greer, 2008; Longano & Greer, 2006; Nuzzolo-Gomez, Leonard, Ortiz, Rivera, & Greer, 2002; Tsai, 2003; Tsai & Greer, 2006). This systematic stimulus-stimulus pairing procedure involves the rotation of pairing trials and test trials. During the pairing trial the stimulus to be conditioned is presented together with conditioned reinforcers (e.g., generalized or prosthetic reinforcers). The schedule of reinforcement is variable and consists of two or three presentations of the conditioned reinforcer per pairing trial. If the student emits any behavior irrelevant to the target behavior, the instructor removes the stimulus, re-presents the stimulus when the student is attending, and restarts the pairing trial. After the completion of the pairing trial (the participant emits the target behavior for the whole interval), the instructor implements a test trial. The test trial is of equal time duration as the pairing trial. No pairing or prompting is delivered during the test interval, only the presence or absence of the target behavior is observed. If the student emits an incorrect response, stereotypy and/or passivity during the test trial, the instructor discontinues the test trial, records the data and then immediately presents a new pairing trial. The length of each training and testing trial begins at 5 seconds and 5 seconds are added for each next phase until the student meets criterion in a post- probe phase which is 5 or 10 minute of continuous engagement in the target behavior without stereotypy.

The research in the behavioral field on the conditioning theory showed that the stimulus-stimulus reinforcement pairing procedure was successfully used to condition a variety of previously neutral stimuli: (1) vocal sounds paired with the

delivery of preferred items to induce participants' vocalizations (Yoon & Bennett, 2000; Sundberg, Michael, Partington, & Sundberg, 1996), (2) more correct responses to worksheets (Longano & Greer, 2006), (3) playing ball (Greer, Becker, Saxe, & Mirabella, 1985), (4) books and toys (Nuzzolo-Gomez, Leonard, Ortiz, Rivera-Valdes, & Greer, 2002), (5) observing books (Tsai & Greer, 2006), (6) visual tracking of stimulus (Keohane, Luke, & Greer, 2008), and (7) adult voices (Keohane, Luke, & Greer, 2008) and preference for listening to stories and general awareness (Greer, Pistoljevic, Cahill, & Du, 2011).

Greer, Pistoljevic, Cahill, and Du (2011) tested the effects of a voice conditioning protocol (VCP) on observing response to others, rate of learning acquisition of listener response, and preference to listen to stories in a free play setting. Three preschool-age children diagnosed with autism spectrum disorders participated in this study. All three participants functioned at pre-listener and pre-speaker levels of verbal behavior. The VCP consisted of (1) training sessions in which recorded voices were paired with preferred items using a stimulus-stimulus pairing procedure, and (2) two-button preference probe sessions which were conducted after the criterion of each training phase. During the two-button preference probe sessions, the participant had the option to press a button out of two buttons placed on the table. When the participant pressed one button, the pre-recorded voices started and continued. When the participant pressed the other button, the pre-recorded voices stopped and discontinued. The VCP continued until the participant pressed the button starting pre-recorded voiced and listened to voices during at least 90% of the 60 five second intervals. Prior to and after the completion of the VCP, they observed

the changes in (1) the numbers of instructional trials (i.e., learn units) to achieve educational listener objectives, (2) observing responses, and (3) the numbers of 5 sec intervals during which the participant listened to an adult tell stories in a five minute probe session. The result demonstrated that all participants required less instructional trials to achieve educational listener objectives, emitted more observing responses to others, and listened to an adult tell stories during more intervals.

Sundberg, Michael, Partington, and Sundberg (1996) implemented a stimulus-stimulus pairing procedure to pair a conditioned reinforcer with vocal sounds. The experimenter tickled a participant while he was emitting vocalizations. Through this procedure a conditioned reinforcer (i.e., the playful physical touch) was paired with his vocalizations. Therefore, the stimulus-stimulus pairing for the participant's vocalizations resulted in reinforcement properties, and then he emitted more vocal sounds. The experimenter also investigated the effects of the stimulus-stimulus pairing procedure on the acquisition of a parroting repertoire. During the stimulus-stimulus pairing procedure, sounds and words were paired with previously conditioned reinforcers. The first experiment showed that new vocal responses emerged as a function of the pairing procedure and not as a function of direct reinforcement, echoic training, or a prompting procedure. The second experiment also represented showed that the participants emitted untaught parroting responses following the stimulus-stimulus pairing procedure.

Yoon and Bennett (2000) replicated the findings by Sundberg et al. (1996). The experimenters found that once parroting was acquired through the stimulus-stimulus pairing procedures, those acquired sounds could then be used to begin

instruction for functional speaker behavior. After participants acquired vocal sounds as a result of the pairing procedure, mand instruction was implemented using those sounds but did not result in mands. However, Yoon (1998) in an unpublished dissertation did show that inducing the parroting resulted in mands when participants were subsequently subjected to the Williams and Greer (1993) echoic to mand condition.

Longano and Greer (2006) found that after worksheet skills acquired reinforcing properties correct responses across worksheets increased. They conducted two experiments to test the effects of the stimulus-stimulus pairing procedure on independent play and independent responding to worksheets during seatwork. In both experiments, the stimulus-stimulus pairing procedure was implemented. In Experiment 1, appropriate play on the computer and with toys, and looking at books was increased after the stimulus-stimulus paring procedure. Stereotypy and passivity were decreased after the stimulus-stimulus paring procedure. Experiment 2 represented that the stimulus-stimulus pairing procedure increased working independently on worksheets, the numbers of correct responses to learn units, and completing an activity schedule.

Greer, Becker, Saxe, and Mirabella (1985) conducted two experiments to test the effects of the stimulus-stimulus pairing procedure on participant's preference for conditioned activities and stereotypy. In the first experiment, when two participants played with preferred toys, they did not emit stereotypy. However, after withdrawal of the toys, the participant engaged in stereotypy. After the toys were re-presented, the participant's stereotypy decreased. In the second experiment young severely

developmentally delayed adults who emitted frequent stereotypy , toys were paired with unconditioned reinforcers. After the implementation of the conditioning procedure, participant's stereotypy was observed in fewer intervals, and appropriate play with toys was recorded in more frequent intervals. If the individual has a history of reinforcement paired with activities in his/her repertoire, he/she engages in activities from the enlarged community of reinforcers rather than stereotypy.

Nuzzolo-Gomez, Leonard, Ortiz, Rivera, and Greer (2002) conducted two experiments with 4 participants with autism to test the relationship between either toys or books as conditioned reinforcers for observing or play and their effect on stereotypy and passivity. In the first experiment, the participant engaged in looking at books significantly more than in his baseline in free play and decreased intervals of passivity, after systematic training sessions involving pairings of reinforcers with looking at books. The results of the second experiment showed that the two participants who emitted frequent rates of stereotypy in baseline had significantly fewer intervals of stereotypy after toys were conditioned as reinforcers and toy play increased for all 3 participants.

Other recent studies showed that the conditioning procedures can be implemented to accelerate student's learning by decreasing learn units to criterion (Greer, Pistoljevic, Cahill, & Du, 2011; Greer & Ross, 2008; Keohane, Luke, & Greer, 2008; Keohane, Greer, & Ackerman, 2006; Longano & Greer, 2006; Tsai, 2003; Tsai & Greer, 2006).

Tsai and Greer (2006) showed that the conditioning of books as conditioned reinforcers for preference and observing response resulted in fewer learn units to

criterion for the acquisition of textual responses. They conducted the stimulus-stimulus pairing procedure for conditioning books as reinforcement. The results demonstrated that learn units to criterion on textual responses decreased after the book conditioning procedure, and that three participants maintained preference for books at the one-month follow-up probe.

Keohane, Luke, and Greer (2008) tested the effects of the implementation of the rotated protocol immersion procedure on inducing new verbal developmental capabilities such as observing responses. The participants were three elementary aged participants with autism spectrum diagnoses. The experimenters conducted the rotation of six pre-listener protocols which consisted of 2D visual tracking, 3D visual tracking, conditioning voices, conditioning faces, auditory matching, and sensory matching. The results of this study showed significant increases in the number and the complexity of the participants' auditory and visual observing responses, decreases in their learn-units-to-criterion, increases in their appropriate verbal interactions and a significant decrease in the engagement of non-functional self-talk. This study showed a functional relation between the protocol immersion and the occurrence of foundational verbal developmental capabilities.

According to Greer and Singer-Dudek (2008), conditioned reinforcement can be learned through the observation. In their study, the participants could observe peers receiving discs or strings as consequent reinforcers. After the observational intervention was conducted, the experimenter measured the correct responses in two types of behavior: performance (behavior already acquired) and learning. The results demonstrated that the discs and strings reinforced correct responding for both

performance and acquisition for all participants in the post-intervention condition following the observational intervention during which participants were denied access to string disks while they observed a peer receive them.

The above investigations demonstrate that the auditory MTS instruction affects communication cusps such as the full echoic (Vause, 1998; Vause, Martin, & Yu, 2000; Reinbold, 2000; Chavez-Brown, 2005, Reinbold, 2000; Lee Park, 2005), listener half of Naming (Speckman-Collins, Lee Park, & Greer, 2007; Greer & Ross, 2008), and listener literacy (Chavez-Brown, 2005). Speckman-Collins, et. al. (2007) argued that the auditory MTS instruction provides the source of the listener components of Naming, which would be conditioned reinforcement of voices. Moreover, Longano (2008) also demonstrated that the stimulus-stimulus pairing procedure induced the joining of listener and speaker behavior and Naming.

Therefore, the current experiment I sought to determine whether or not an advanced auditory matching instruction would result in the emergence of speaker-as-own-listener cusps (i.e., Naming, say-do correspondence and self-talk), listener literacy, and increases in participant's full or exact echoic responses. I also sought to determine, in the second experiment if the potential source of the emergence of advanced listener literacy and speaker-as-own-listener cusps resulted in conditioned reinforcement for listening to voices. In Experiment I, I tested the effects of mastery of the advanced auditory matching procedure on participants' advanced listener literacy, full echoic responses, conditioned reinforcement and speaker-as-own cusps.

Chapter II

EXPERIMENT I

Overview

In Experiment 1, I tested the effects of mastery of an advanced auditory match-to-sample (MTS) instruction on the emergence of advanced listener literacy and Naming, and the emission of full echoic responses with elementary school age participants who verbally functioned on more advanced levels than the preschool level like those Speckman-Collins, Lee Park, and Greer's (2007) study.

In this chapter, I present an experimental analysis of the auditory match-to-sample (MTS) instruction as the protocol to induce advance listener literacy and Naming. A counterbalanced delayed multiple probe across participants design was used in this study (Cooper, Heron, & Heward, 2007). Lee Park (2005) and Speckman-Collins, Lee Park, and Greer (2007) showed a functional relation between the mastery of a basic auditory MTS protocol and the emergence of the listener component of Naming with the participants who functioned on pre-listener and pre-speaker levels of verbal behavior. In this study, I tested the effects of mastery of the advanced auditory MTS instruction on both listener and speaker components of Naming with participants who had more advanced verbal behavior levels.

Method

Participants

Four elementary school students with Autism Spectrum Disorders (ASD) served as the participants for this study. They attended one of several district based self-contained classrooms that implemented the system of Comprehensive Application of Behavior Analysis to Schooling (CABAS®) model (Greer, 2002; Selinske, Greer, & Lodhi, 1991). The ratio in the classroom was 8 students: 1 teacher: 2 teaching assistants. All long-term and short-term objectives for the students in the school were determined based on the CABAS® International Curriculum and Inventory of Repertoires f or Children from Preschool through Kindergarten (Greer & McCorkle, 2009) and New York State standards (http://www.emsc.nysed.gov/deputy/ documents/ learnstandards.htm). The classroom teachers delivered almost all instruction using learn unit presentations (Albers & Greer, 1991; Greer & McDonough, 1999).

Participant A was a seven-year-old male who functioned at the listener, speaker, early reader, and early writer levels of verbal behavior. He had basic listener literacy, responses to his/her own textual responding as a listener, print transcription, and dictation in his repertoire. Participant B was an eight-year-old female who functioned at the listener, speaker, early reader, and early writer revels of behavior. She had basic listener literacy, print transcription, and dictation in her repertoires. Participant C was a seven-year-old male who functioned at the listener, speaker, early reader, and early writer levels of verbal behavior. He had basic listener literacy, responses to his/her own textual responding as a listener, print transcription, and

dictation in his repertoire. Participant D was a seven-year-old male who functioned at listener and early speaker levels of verbal behavior. He had basic listener literacy, responses to own textual responding as listener, print transcription, and dictation in his repertoire. (See Table 1 and Table 2 for a complete description of all participants). All participants were selected for the study due to their inexact echoic responses or due to low numbers of correct responses to vocal directions.

Table 1

Standardized test score of participants

Participant	Standard Scores
A- 7 year old male diagnosed with autism	(Conducted in 2010) Stanford-Binet Intelligence Scale: Fifth Edition - Full Scale IQ 58 Expressive Vocabulary Test - Total SS:97,%ile:42:AE:7.3 Goldman Fristoe Test of Articulation Sounds In Words - SS:80;%ile:14;AE:5.2 Receptive One-Word Picture Vocabulary Test Total - SS:85;%ile:16;AE:6.0 Test for Auditory Comprehension of Language-3 Vocabulary - SS:6; %ile:9;AE:5.9 Test for Auditory Comprehension of Language-3 Grammatical Morphemes - SS:6;%ile:9;AE:5.3 Test for Auditory Comprehension of Language-3 Elaborated Phrases and Sentences - SS:6;%ile:9;AE:5.6

B- 8 year old female diagnosed with autism	(Conducted in 2010) Expressive Vocabulary Test Total SS:48; AE: 4.5 Test for Auditory Comprehension of Language-3 Elaborated Phrases and Sentences SS: 1; AE; 3 Test for Auditory Comprehension of Language-3 Grammatical Morphemes SS:5; AE:5.3 yrs; 5% Test for Auditory Comprehension of Language-3 Vocabulary SS:2; AE: 4.3; 1% Goldman Fristoe 2 Speech Articulation SS:88; AE: 4.11
C- 7 year old male diagnosed with autism	(Conducted in 2010) Stanford-Binet Intelligence Scale: Fifth Edition - Full Scale IQ 66 Expressive Vocabulary Test Total - SS:88;%ile:21;AE:6.0 Goldman Fristoe Test of Articulation Sounds In Words - SS:97;%ile:23;AE:5.6 Test for Auditory Comprehension of Language-3 Elaborated Phrases and Sentences -SS:5;%ile:5;AE:4.4 Test for Auditory Comprehension of Language-3 Grammatical Morphemes -SS:6;%ile9;AE:5.0 Test for Auditory Comprehension of Language-3 Vocabulary - SS:6;%ile;9;AE:5.9
D- 7 year old male diagnosed with autism	(Conducted in 2007) Stanford-Binet Intelligence Scale: Fifth Edition - Verbal IQ SS=46 Stanford-Binet Intelligence Scale: Fifth Edition - Non-Verbal IQ SS=46 Stanford-Binet Intelligence Scale: Fifth Edition - Full Scale IQ SS=43 (Conducted in 2010) Test for Auditory Comprehension of Language-3 Vocabulary - SS:5, AE: 4.3 Test for Auditory Comprehension of Language-3 Grammatical Morphemes - SS:2; AE:3.6 Goldman Fristoe 2 Speech Articulation - SS:86, AE: 5.0

Table 2

Verbal behavior levels of participants. O indicated that a cusp or capability is in a repertoire. X indicated that a cusp or capability is not in a repertoire.

Participant	Verbal Behavior Levels	Related Cusps or Capabilities		
			Prior to the Auditory MTS	After Mastery of Auditory MTS
A	Listener, Speaker, Early Reader (below-grade-level of reader), Early Writer (below- -grade-level of writer)	Basic Listener Literacy	O	O
		Generalized Matching	O	O
		Advanced Listener Literacy	X	O
		Listener Half Naming	X	O
		Full Naming	X	O
B	Listener, Speaker, Early Reader(below-grade-level of reader), Early Writer(below-grade-level of writer)	Basic Listener Literacy	O	O
		Generalized Matching	O	O
		Advanced Listener Literacy	X	O
		Listener Half Naming	X	O
		Full Naming	X	X
C	Listener, Speaker, Early Reader(below-grade-level of reader), Early Writer(below-grade-level of writer)	Basic Listener Literacy	O	O
		Generalized Matching	O	O
		Advanced Listener Literacy	X	O
		Listener Half Naming	X	O
		Full Naming	X	O

D	Listener, Early Speaker, Early Reader, (below-grade-level of reader), Early Writer (below-grade-level of writer)	Basic Listener Literacy	O	O
		Generalized Matching	O	O
		Advanced Listener Literacy	X	O
		Listener Half Naming	X	O
		Full Naming	X	X

Setting

All pre- and post-intervention sessions took place at child-sized desks, a large rectangular table located in the back of the classroom, or in a small tutoring room. Both experimenter and children sat in child-sized chairs during all sessions. Other members of the class received one-to-one or small group instruction during the experimental sessions.

During intervention sessions, participants sat directly in front of the computer screen. Two speakers were connected to the computer with the volume adjusted so that the participants could hear the words clearly. The experimenter and independent observer sat to the right of the participant. Instructional sessions took place at one of two computers. Both computers contained an advanced auditory MTS Flash® program (designed by the experimenter). One of the computers used during the auditory MTS program had an external transparent touch screen secured with Velcro.

Materials

In the pre- and post-intervention sessions, the experimenter conducted unconsequated probe sessions to test for the Naming capability. Korean letters with contrived names were used as the stimuli (see Table 3). These letters were computer-generated and printed out in 150 font size on white computer paper. Each white paper was approximately one fourth the size of 8.5 x 11 inch piece of paper.

Table 3

2 dimensional stimuli sets used during Naming probe sessions

Set	Stimuli
1	ㅎ(Habuah), ㅍ(Prapa), ㅂ(Baboin), ㄷ(dig-it)
2 (Novel Set)	ㅆ(Bam), ㅋ(cal), ㄹ(roll), ㅊ(chew)

In addition to pre-and post-intervention Naming probe sessions, the experimenter conducted probe sessions on echoic responses. During these sessions, the experimenter presented 100 English language words and 40 Korean language words to which participants were required to emit echoic responses (see Table 4 & Table 5).

Data sheets containing target words were used during probe sessions. Data sheets included tables developed by Excel, which had the target words and cells for recording the response. In addition to Naming probes and echoic responses, the experimenter also conducted pre-and post-intervention advanced listener literacy probes with a vocal direction and an unrelated visual distracter (e.g., saying touch your ear while the experimenter touched his mouth). Data for these sessions were recorded on a pre-made data sheet that included the complete list of vocal directions and visual distracters (see Table 6).

Table 4

100 English words used during echoic probe sessions

1. About	36. Independent	71. That's
2. Again	37. Into	72. Their
3. Almost	38. Its	73. Then
4. Also	39. Journal	74. Through
5. Always	40. Laugh	75. Trouble
6. Another	41. Let's	76. Unhappiness
7. Anyone	42. Lovable	77. Until
8. Are	43. Made	78. Usually
9. Ask	44. Member	79. Vacation
10. Beautiful	45. Mine	80. Very
11. Because	46. Myself	81. Want
12. Before	47. Neighbor	82. Was
13. Buy	48. New	83. Wave
14. Can't	49. News	84. We're
15. City	50. No	85. Wear
16. Community	51. Off	86. Weather
17. Confusion	52. One	87. Went
18. Could	53. Our	88. Were
19. Countries	54. Owl	89. Who
20. Didn't	55. People	90. Whole
21. Discover	56. Prettier	91. Winner
22. Doesn't	57. Prettiest	92. With
23. Don't	58. Pretty	93. Won
24. Enough	59. Probably	94. Won't
25. Especially	60. Question	95. Wouldn't
26. Everybody	61. Really	96. Write
27. Everything	62. Recycle	97. Writing
28. Except	63. Right	98. Yell
29. Exciting	64. Said	99. Young
30. Favorite	65. School	100. You're
31. Friendly	66. Sister	
32. General	67. Something	
33. Getting	68. Sometimes	
34. Hopeless	69. Teacher	
35. Impossible	70. Terrible	

Table 5

40 Korean words used during echoic probe sessions

1. Kuksu (noodles)	21. Nampyeon (husband)
2. Adeul (son)	22. Norang (yellow)
3. A-nae (wife)	23. Omma (mom)
4. Annyong (hello)	24. O-reun-chok (right)
5. A-re-ro (down)	25. Parang (blue)
6. Bop (rice)	26. Ppalgang (red)
7. Chal-buen (short)	27. Pudu (ferry pier)
8. Chihach'ol (subway)	28. Pyongwon (hospital)
9. Chin-gu (friend)	29. Saengson (Fish)
10. Chog-ee (there)	30. Sogogi (beef)
11. Ddok-ba-ro (straight)	31. Sogum (salt)
12. Ga-ka-un (near)	32. Sugon (Towel)
13. Geomjeong (black)	33. Ttal (daughter)
14. Gin (long)	34. Unhaeng (Bank)
15. Hayang (white)	35. Upyo (stamp)
16. Huchu (black pepper)	36. Uyu (milk)
17. Hwajangshil (toilet)	37. Wenchok (left)
18. Jido (map)	38. Wiro(up)
19. Kicha (train)	39. Yyogee (here)
20. Konghang (airport)	40. Kong (beans)

Table 6

Vocal directions and visual distracters used during listener literacy probe sessions.

Vocal directions	Visual distracters
Touch nose	Touch mouth
Touch ear	Touch eyes
Clap hands	Stand up
Blow kiss	Roll arms
Roll arms	Touch nose
Touch eyes	Touch ear
Touch mouth	Clap hands
Stand up	Blow kiss
Stomp feet	Touch head
Tap laps	Touch belly
Touch arm	Touch feet
Tap table	Touch knees
Touch head	Tap table
Touch belly	Touch arm
Touch feet	Tap laps
Touch knee	Stomp feet
Wave hands	Touch elbow
Raise arms	Touch shoulder
Touch elbow	Raise arms
Touch shoulder	Wave hands

Participant D also participated in the pre-and post-intervention sessions that presented him with a three or four word phrase that he was required to emit echoic responses since he emitted high number of incorrect responses to phrases in non-instructional sessions. The sessions consisted of a list of 20 different phrases (see Table 7).

Table 7

Three or four word phrases used during echoic probe sessions for Participant D.

Three word phrases	Four word phrases
Watch me wiggle.	I cannot play.
Mom is waiting.	Come and help mother.
Follow me over.	Sally is a baby.
They are pretty.	Go and get it.
Let's tell time.	I want a car.
Plants get food.	Come with me, Brendan.
They make bricks.	Jane is in the `house.
Color the flower.	I see you, Dick.
Roses are red.	Little spot looks up.
I will change.	My ball is yellow.

During the intervention sessions, learn units were presented through the auditory MTS program using a computer. During all pre-post- and intervention sessions, all data were recorded on computer-generated data sheets with a black pen, and graphed at the end of each session.

Procedure

Design

A counterbalanced delayed multiple probe across participants design was used in this study (Johnston & Pennypacker, 1993). Probe sessions were time-lagged across participant pairs to control for maturation and history. Prior to and following auditory MTS instruction, the experimenter conducted probe sessions measuring unconsequated correct responses to advanced listener literacy probe trials, the untaught listener and speaker responses for Set 1 words (i.e., Naming), and the numbers of full echoic responses to 100 English words and 40 Korean words. After the participant completed all the phases of the auditory MTS instruction, the experimenter conducted probes for the listener and speaker components of Naming for a novel set of stimuli (Set 2) as well as their initial set (Set 1).

The experimental sequence of the auditory MTS training phases was counterbalanced. Participants A and C began their intervention by matching single words. Participants B and D began their intervention by matching phrases. That is, Participant A began the intervention sessions in Phase 1 of the auditory MTS program that consisted of single word training sets of stimuli. To counter balance the experimental sequence, Participant B began the intervention sessions on Phase 7 of the program which consisted of phrase training sets of stimuli with one different word.

Participant C began the intervention sessions in Phase 1 consisting of single word training sets of stimuli. Participant D began the intervention sessions in Phase 7 consisting of phrase training sets of stimuli with one different word.

Table 8

Experimental Sequence of Experiment 1

Participant	Sequence of Probes or Interventions							
A	Pre-auditory MTS probe	Auditory MTS instruction for single words	Post-single word set probe	Auditory MTS instruction for phrases	Post-auditory MTS probe			
B		Pre-auditory MTS probe	Auditory MTS instruction for phrases	Post-phrase set probe	Auditory MTS instruction for single words	Post-auditory MTS probe		
C			Pre-auditory MTS probe	Auditory MTS instruction for single words	Post-single word set probe	Auditory MTS instruction for phrases	Post-auditory MTS probe	
D				Pre-auditory MTS probe	Auditory MTS instruction for phrases	Post-phrase set probe	Auditory MTS instruction for single words	Post-auditory MTS probe

After Participants A and B completed their respective halves of the auditory MTS program and participated in the post-intervention probe sessions, Participant C began the intervention phase with single words and Participant D began the intervention phase with phrases. Refer to Table 8 for sequence of the study.

Independent Variable: Mastery of Advanced Auditory MTS Instruction

Mastery of the advanced auditory match-to-sample (MTS) instruction was the independent variable used during the study. The advanced auditory MTS instruction consisted of six phases (Phase 1 through 6) of matching single words, and three

phases (Phase 7 through 9) of matching phrases (see Table 9). This auditory MTS instruction was presented by the experimenter in learn units. The auditory MTS Flash® program displayed three circular red buttons (2.5 inch diameter), one at the top center of the screen and two below it in the bottom corners of the screen. A solid horizontal line divided the top and bottom buttons. The top button produced the sample word or phrase, and the two buttons located below produced the exemplar and non-exemplar word or phrase. Each learn unit was delivered by the experimenter touching or clicking the top center button (the sample stimuli), followed by each of the bottom buttons, which were the exemplar and non-exemplar. The experimenter touched the top button again and said "match." The participants had a three second inter-response interval in which they needed to respond by pressing a bottom button. Correct responses were consequated with reinforcement in the form of praise and prosthetic reinforcers, such as edibles and tokens that could later be exchanged for back-up reinforcers (e.g., free play time, internet web sites, etc.). If the participant emitted an incorrect response, the experimenter used the correction procedure to correct the response. Correction procedures required that the participant repeat the correct response, which was not reinforced.

Criterion for mastery of each phase was set at 90% accuracy across two consecutive sessions or 100% accuracy at the first session of a target phase. Once the participants met criterion for each phase, the next set of phases was introduced. Participants progressed through the auditory MTS program phases until they completed all the training sets phases consisting of single words or phrases. After the participants completed either the single word or phrase training set they participated

in the post-intervention probe sessions that were identical to the pre-intervention sessions. After these sessions, the participants began the next set of intervention that consisted of the set of auditory MTS they had not completed before (single words or phrases).

Dependent Variable

The dependent variables in the current study were (1) advanced listener literacy, (2) the emergence of Naming, and (3) full echoic responses. Advanced listener literacy was tested by presenting the participants with a vocal direction while simultaneously presenting a visual distracter prompt (e.g., saying touch your ear while the experimenter rolled arms). A correct response during these sessions was defined as the response to the vocal direction only within three seconds of the teacher presented antecedent. However, if the participant responded by imitating the visual prompt, the response was marked incorrect. Even if the participant followed the vocal direction immediately following the visual imitation, the response was still considered an incorrect response.

In addition to advanced listener literacy, the acquisition of joint stimulus control across the listener and speaker components of Naming for two-dimensional stimuli were measured as a dependent variable. The target listener behavior included point-to responses; target speaker behaviors included tact and intraverbal responses to Set 1 and 2 (i.e., a novel set).

Table 9

Single words and phrases used during the advanced auditory MTS instruction.

Sets	Phases	Stimuli
Single words	Phase 1	Using end rhymes as non-exemplars which should not be matched with target words: Plate, eight Night, fight Rain, pain Pay, say Fun, sun
	Phase 2	Using last syllable rhymes as non-exemplars which should not be matched with target words: Tumor, harbor Explain, plain, Humanity, zesty Threw, breakthrough Pleat, complete
	Phase 3	Using double rhymes as non-exemplars which should not be matched with target words: Adoring, exploring, Walking, talking Humming, coming Refrigerator, alligator Friction, addiction
	Phase 4	Using triple rhymes as non-exemplars which should not be matched with target words: Frightening, brightening Combination, explanation Antelope, cantaloupe Greenery, scenery Mightily, vitally

	Phase 5	Using beginning rhymes as non-exemplars which should not be matched with target words: Table, tailor Car, carpet Soccer, sauce Sole, soil Game, gain
	Phase 6	Using first syllable rhymes as non-exemplars which should not be matched with target words: Carrot, caring Tulip, twosome Extra, exhale Triple, trim Five, fire
Phrases	Phase 7	Phrases are pair of phrases that have one different word out of two words. The participant was required to match exactly identical phrases: Blue hat, red hat Two cats, three cats First floor, second floor Music class, art class Cold water, hot water Blue hat, blue cat, Two cats, two bears, First floor, first time Music class, music teacher
	Phase 8	Phrases are pair of phrases that have one different word out of three words. The participant was required to match exactly identical phrases: My best friend, your best friend A fast dog, the fast dog A big triangle, blue big triangle My best friend, my little friend The fast dog, the slow dog

	A big triangle, a small triangle
	My best friend, my best book the fast bird, the fast dog a big triangle, a big circle
Phase 9	Phrases are pair of phrases that have one different word in a sentence. The participant was required to match exactly identical phrases: The book is on the table. The pen is on the table. Can you draw an ant? Can I draw an ant? Bear sits on the ground. Turkey sits on the ground.
	The book is on the table. The book is over the table. Can you draw an ant? Can you get an ant? Bear sits on the ground. Bear walks on the ground.
	The book is on the table. The book is on the cabinet. Can you draw an ant? Can you draw an elephant? Bear sits on the ground. Bear sits on the tree.

Participants were first taught to visually match as the experimenter tacted the stimuli using learn units. The participants met a criterion for the visual matching, and then participated in unconsequated probe sessions where they were to point, tact, or respond with an intraverbal tact (impure tact). The responses to these sessions indicated whether or not the participants met criterion (80% accuracy for all listener and speaker responses) for full Naming.

The numbers of echoic responses were also measured as full echoic responses, partial echoic responses, and vocalizations. Full echoic responses were defined as responses that had point-to-point correspondence with the experimenter presented vocal antecedent ("because" in response to "because"). Partial echoic responses were

defined as responses with at least a partial point-to point correspondence (“wecyle” in response to “recycle” or “aboved” in response to “above”). Vocalizations represented occurrences of a response, but the response had no points of correspondence to the original antecedent (“bap” in response to “sogum”).

An additional dependent variable was measured for Participant D. Due to the participant’s inexact echoic repertoire for three and four word phrases, the experimenter measured the numbers of full echoic responses to three and four word phrases. He participated in a pre-intervention session to make sure he could echo all the words separately that were used in the three and four word phases that would be used to measure three and four word echoic responses. Once it was determined that the participant could fully echo each word, the experimenter presented 20 different three or four word phrases that the participant was to echo. Responses were recorded as full echoic responses if the participant correctly echoed the phrase with point-to point correspondence to the probe words. The response was recorded incorrect if the response had partial echoic responses throughout the whole phrase.

Data Collection

During pre- and post- intervention probe sessions that measured echoic responses to both English and Korean words, the experimenter recorded a plus (+) for full echoic responses, a (p) for partial echoic responses and a minus (-) for incorrect vocalizations. During all other pre-and post-intervention sessions and all intervention sessions, data were recorded with a plus (+) for a correct response or a minus (-) for an incorrect response. All pre-and post-intervention sessions and all intervention session were graphed immediately following each session. During all auditory MTS

sessions, data were recorded with a plus (+) for a correct matching response or a minus (-) for an incorrect matching response.

Interobserver Agreement

Interobserver agreement was calculated for 100% of pre- and post-intervention sessions for all participants. Interobserver agreement (IOA) was conducted using the Teacher Performance Rate and Accuracy (TPRA) scale in a situation or from video recordings to test fidelity of treatment and accuracy for participant responses (Ingham & Greer, 1992). Two other independent observers who had previously completed training procedures to their accuracy observing and recording correct and incorrect responses. After independent observers completed calibration procedure using other individuals that were not used in the experiment, the observers provide IOA. Interobserver agreement was calculated by dividing the number of pointo-to-point agreements and disagreement by the total number of agreements plus disagreements and multiplied by 100% (Johnston & Pennypacker, 1993).

Dependent Variable. The experimenter and observers simultaneously and independently recorded data during pre-and post-intervention sessions and then compared their data to each other at the conclusion of each session. Interobserver agreement was 100% across all probe sessions across all participants.

Independent Variable. Interobserver agreement was also conducted for the advanced auditory MTS instructional sessions. Interobserver agreement was calculated for 55% of intervention sessions for Participants A and B and was100%. Interobserver agreement was calculated for 43% of intervention sessions for

Participant C at 100% agreement. Interobserver agreement was calculated for 48% of intervention sessions for Participant D at 100% agreement.

Results

Advanced Listener Literacy. Figure 1 shows the numbers of unconsequated correct responses to the advanced listener literacy probe trials in which a vocal direction was presented with a visual distracter prompt. Participant A emitted 11 correct responses out of 20 probe trials in the pre-probe session. Following the auditory MTS instruction for single words, however, his correct responses increased to 16. After all auditory MTS phases, he emitted 18 correct responses out of 20 probe trials. Participant B's correct responses also increased to 15 after the phrase phases of auditory MTS and to 17 after all auditory MTS phases. Participants C and D emitted 4 and 8 correct responses, respectively in the pre-intervention probe and after mastery of one set of auditory phases they emitted 17 and 15 correct responses out of 20 probe trials. After all phases of the auditory MTS instruction, Participants C and D emitted 19 and 17 correct responses out of 20 probe trials, respectively.

Naming. Figure 2 shows the participants' correct responses to the untaught listener or speaker responses to the stimuli sets following the mastery of the matching responses. Participant A emitted 9 point-to responses (i.e., listener response), 4 tact responses, and 5 intraverbal responses to Naming probe stimuli Set 1, following the mastery of the matching response. Participant B emitted 10 point-to responses (i.e., listener response), 3 tact responses, and no intraverbal responses to Naming probe stimuli Set 1, following the mastery of the matching response. Following the mastery of single word training set of the advanced auditory MTS phases,

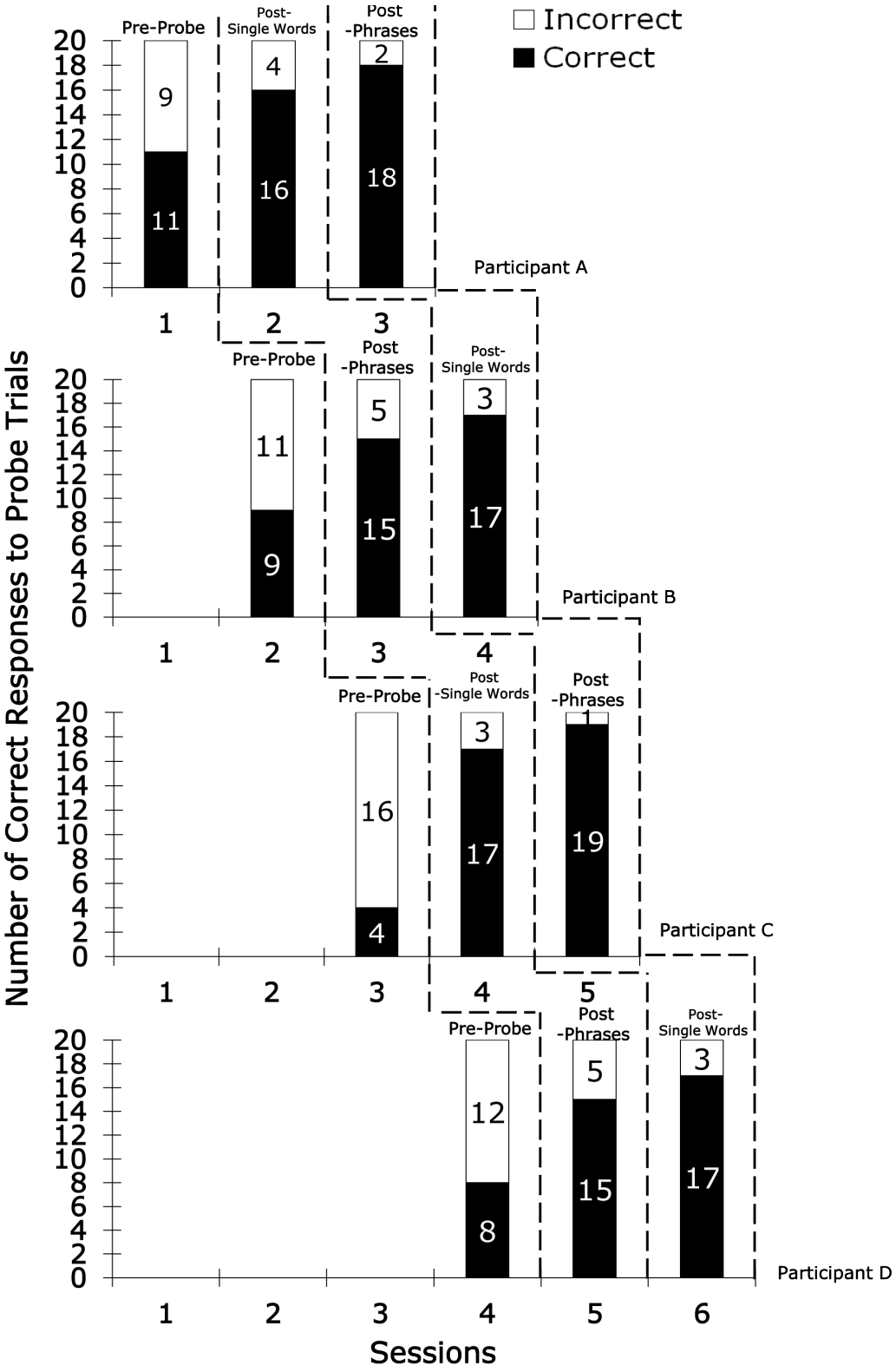

Figure 1. Number of correct responses to probe trials for 20 vocal directions which were simultaneously presented with a visual distracter prompt for participants.

Participant A's correct responses increased to 20 point-to responses (i.e., listener response), 10 tact responses, and 10 intraverbal tact responses to Set 1. After this participant met criterion on all auditory MTS phases, he responded 100% correctly across all untaught responses to a novel set of stimuli. Following the mastery of a phrase training set of the advanced auditory MTS phases, Participant B also emitted more correct responses for untaught responses: 14 point-to (i.e., listener responses), 10 tact, and 8 intraverbal responses to Set 1. After mastering all auditory MTS sessions, Participant B emitted 16 correct point responses, and 13 and 14 tact and intraverbal responses to a novel set of stimuli.

Participant C emitted 18 point-to (i.e., listener responses), 8 tact, and 10 intraverbal responses in the pre-probe session. After the completion of single word training set of the advanced auditory MTS phases, he emitted 100% correct listener responses and 15 correct tact and intraverbal responses. After meeting criterion on all sessions, he emitted 20 correct listener responses, 17 correct tact, and 17 correct intraverbal responses. Participant C emitted 100% correct responses across all responses to the novel set of stimuli used after the completion of all the phases. Participant D emitted 10 point-to (i.e., listener responses), and no tact and intraverbal responses during pre-intervention sessions, but after mastery of all phrase auditory MTS phases he emitted 4 tact responses and an increased number of listener responses with 15. After the completion of all auditory MTS phases, Participant D emitted 20 correct point-to responses (i.e., listener responses) and 10 correct tact and intraverbal responses. To a novel set of stimuli, the participant emitted 100% correct listener responses, and 75% correct tact and intraverbal responses.

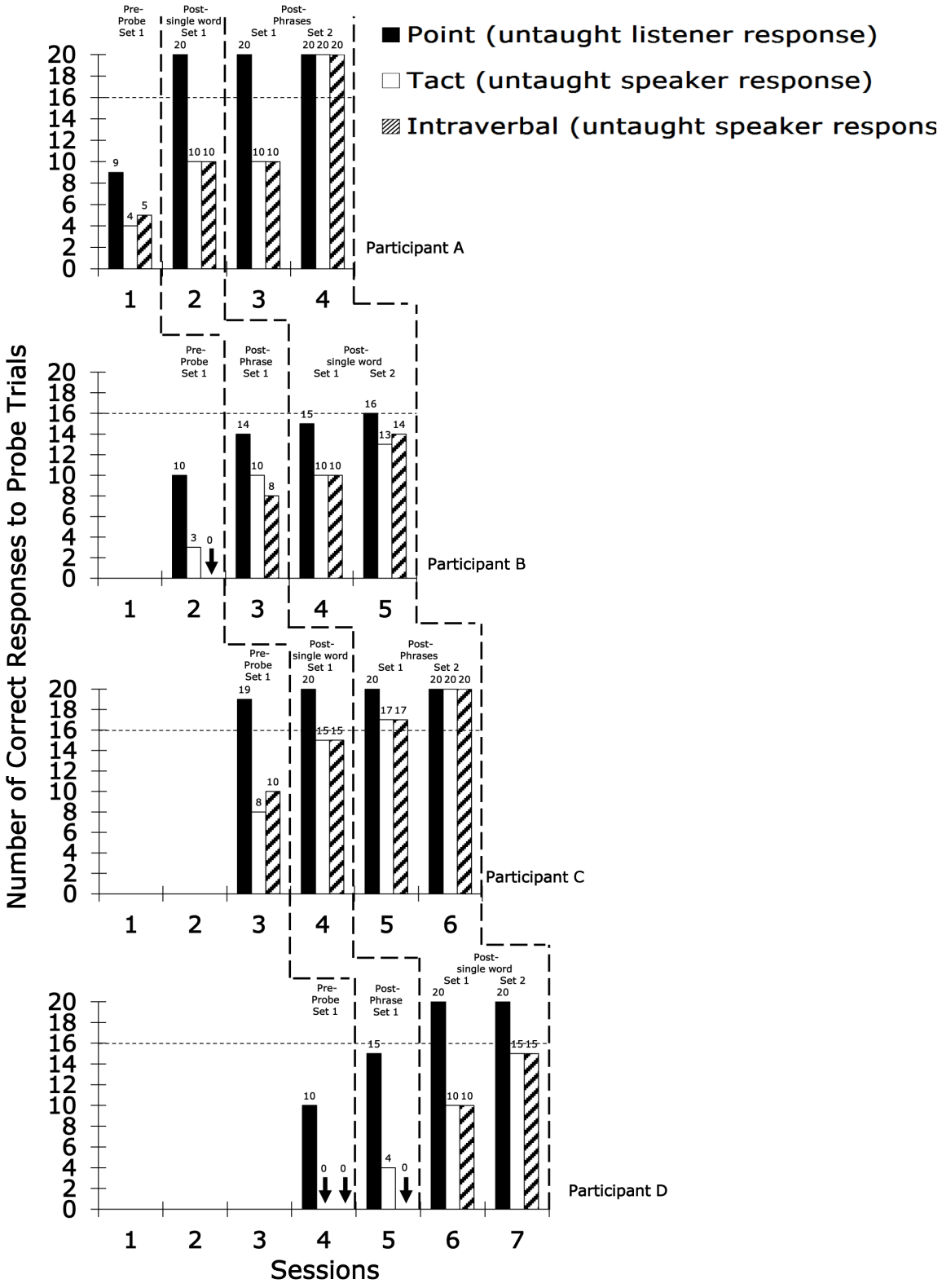

Figure 2. Number of correct untaught listener and speaker responses to 2D stimuli for Participants A, B, C, and D.

Therefore, Participants A and C acquired full Naming through the advanced auditory MTS instruction. Participants B and D's correct untaught listener and speaker responses increased significantly, and achieved a listener half of Naming which had not been in their repertoires prior to the advanced auditory MTS instruction. However, Participants B and D did not achieve the criterion for the emergence of full Naming which was set at 80% correct response across both listener and speaker responses.

Echoic Responses to Korean Novel Sounds. Figure 3 shows the numbers of full, partial echoic, and vocalizations to 40 Korean novel sound words. Participant A emitted 13 full echoic responses, 24 partial echoic responses, and 3 vocalizations (incorrect echoic responses) in the pre-probe session. Following the mastery of the advanced auditory MTS phases of single words, his full echoic responses increased from 13 to 26 whereas his partial echoic responses decreased from 24 to 14. After mastering all auditory MTS sessions, he emitted 34 full echoic responses and 6 partial echoic responses. No incorrect vocalizations were observed. Participant B emitted 14 full echoic responses, 26 partial echoic responses, and no vocalizations. Following the mastery of the advanced auditory MTS phases of phrases, her correct responses showed similar number of full and partial echoic responses. But, after all the mastery of all auditory MTS sessions her full echoic responses increased to 24.

Participant C emitted 16 full echoic responses, 20 partial echoic responses, and 4 vocalizations in the pre-probe session. After mastering the single words phases of the auditory MTS instruction, he emitted 24 full echoic responses and 16 partial echoic responses. After the mastery of all auditory MTS sessions,

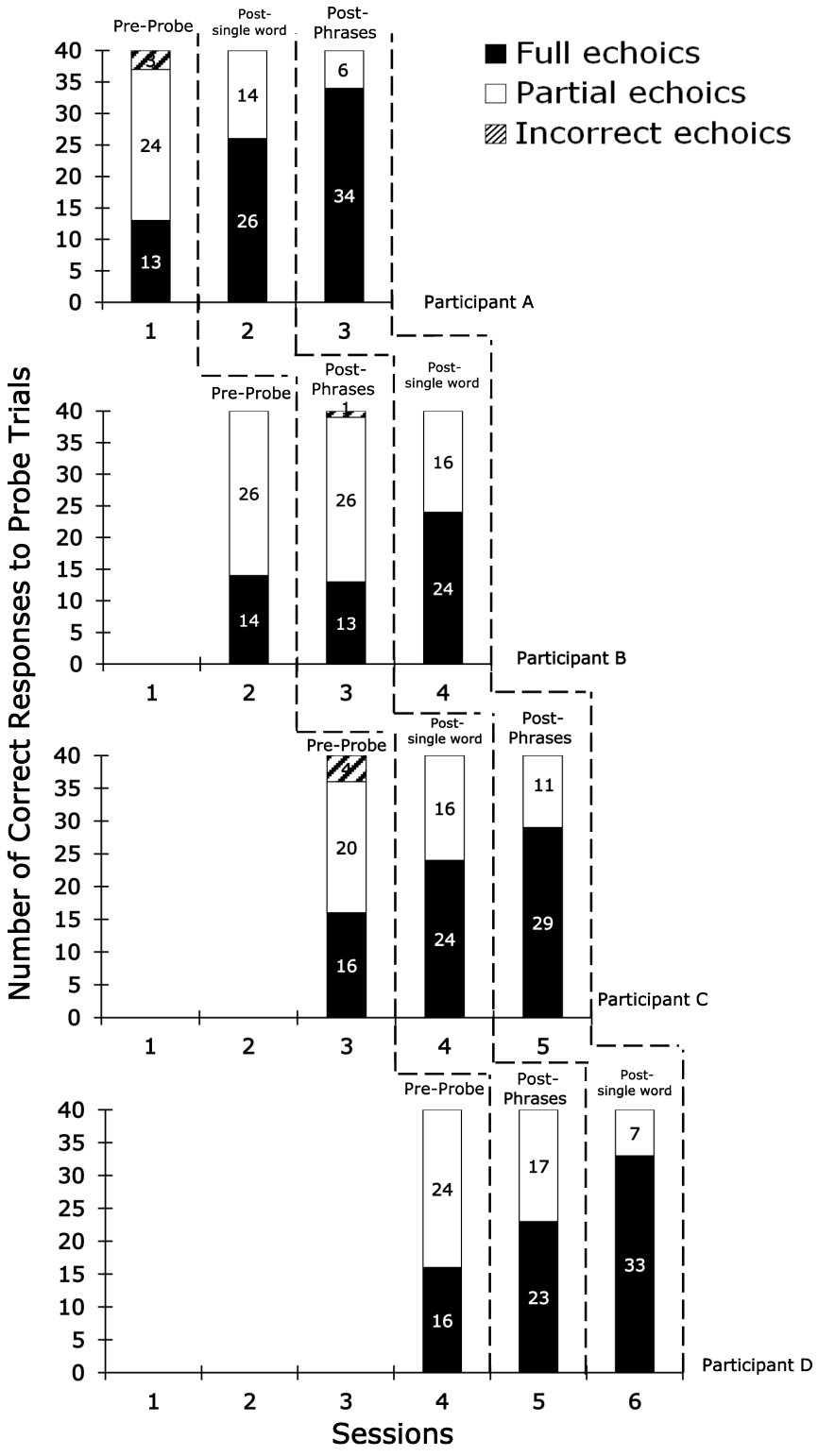

Figure 3. Number of full, partial, and incorrect echoic responses to 40 Korean novel sound words for Participants A, B, C, and D.

he emitted 29 full echoic responses, and 11 partial responses. Participant D emitted 16 full echoic responses, 24 partial echoic responses, and no vocalization in the pre-probe session, and after mastering the phrase phases of auditory MTS instruction he emitted 23 full echoic responses and 17 partial echoic responses. After mastering all phases of the auditory MTS instruction, he emitted 33 full and 7 partial echoic responses.

Echoic Responses to English Words. Figure 4 shows participants' full, partial echoic, and vocalizations to 100 English words that were not trained through the advanced auditory MTS instruction. Through the advanced auditory MTS instruction for single words, Participant A's full echoic responses increased from 80 to 90. After mastery of all phases, they increased again to 97. His partial echoic responses decreased from 20 to 10 to 3. Participant B's results also showed the same trend. Through the advanced auditory MTS instruction for phrases, her full echoic responses increased from 51 to 64; partial echoic responses decreased from 49 to 36. Her full echoic responses increased after mastery of all auditory MTS phases to 72, with 28 partial echoic responses. Participant C emitted 73 full echoic responses, 27 partial echoic responses, and no vocalizations in the pre-probe session. After the auditory MTS single sessions full echoic responses increased to 94, with 6 partial echoic responses, and full echoic responses increased again after the phrases session to 98 full echoic responses with 2 partial echoic responses. Participant D emitted 66 full echoic responses, 33 partial echoic responses, and 1 incorrect vocalization in the pre-probe session, but after mastery of all the auditory MTS sessions, he emitted 89 full echoic responses and 11 partial echoic responses.

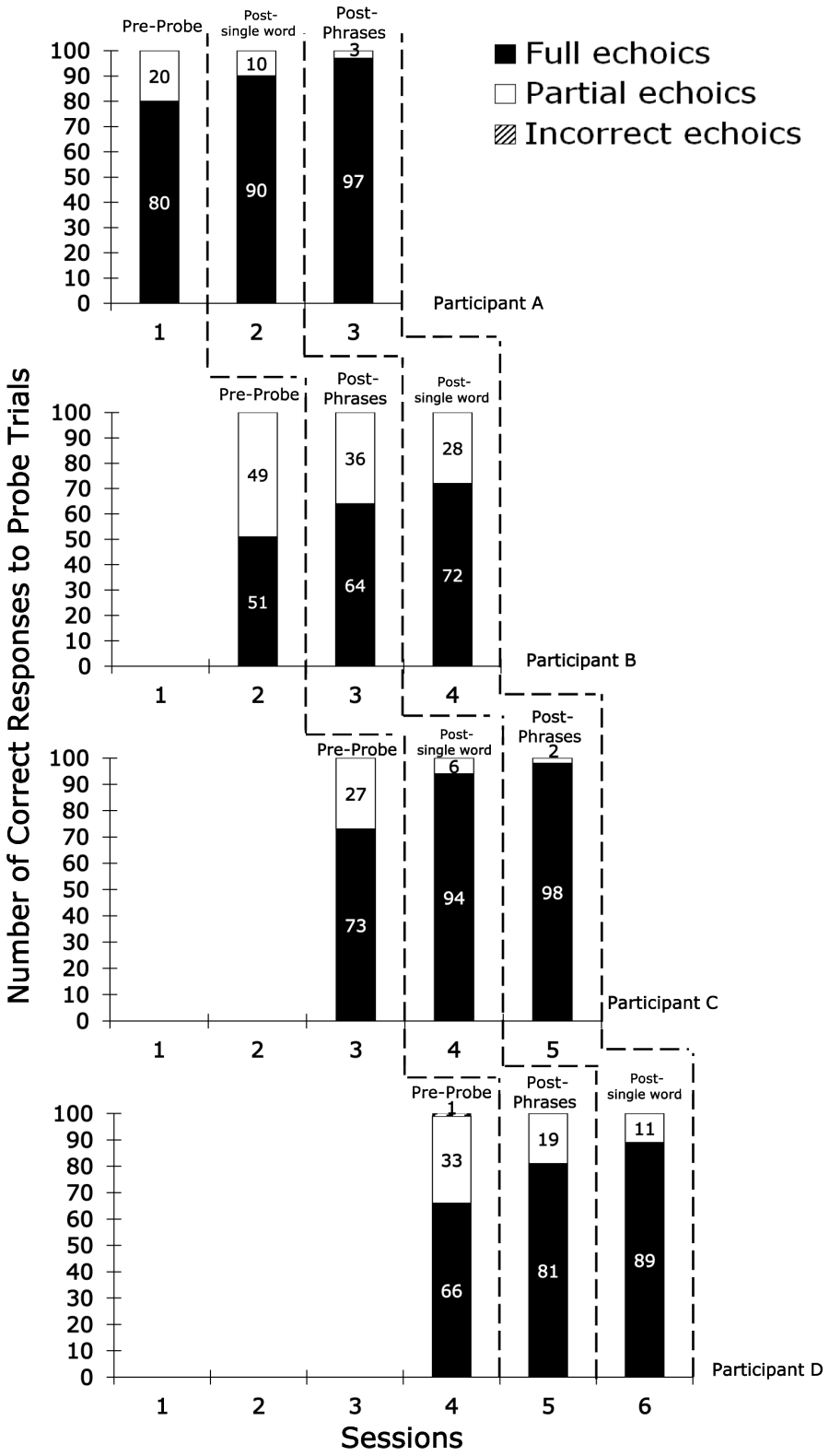

Figure 4. Number of full, partial, and incorrect echoic responses to 100 English words for Participants A, B, C, and D.

Echoic Responses to Phrases. Figure 5 shows Participant D's full echoic responses to three and four word phrases. He emitted 8 full echoic responses to 20 probe trials. After mastering the phrase phases of the auditory MTS instruction his correct echoic responses increased to 14, which remained constant after the single auditory MTS phases.

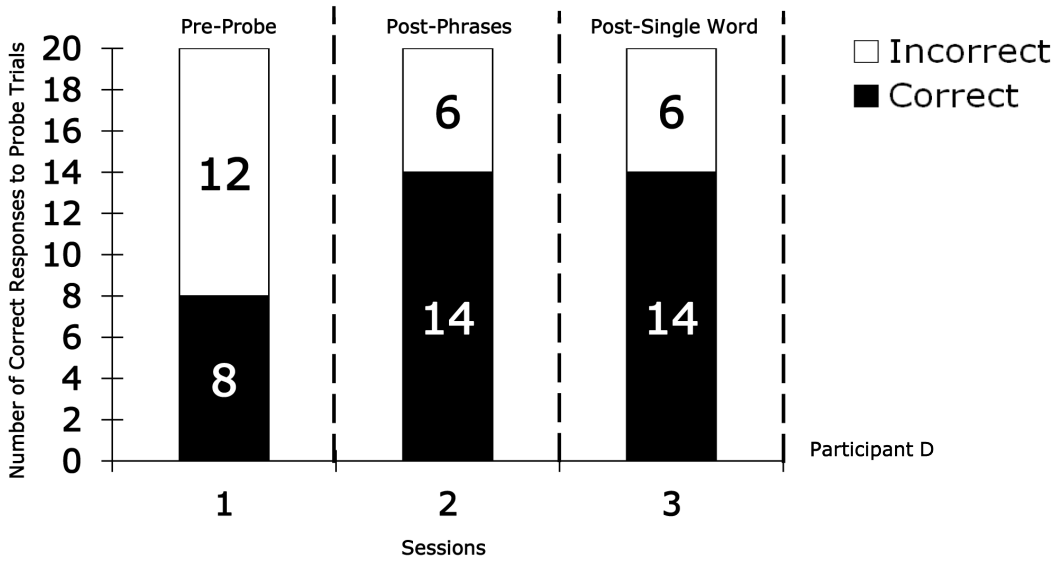

Figure 5. Number of full echoic responses to 20 three or four word phrases for Participant D.

Correct Responses during the Intervention. During the advanced auditory MTS sessions (Figure 6 and 7), Participant A required 20 sessions to complete all 6 auditory MTS phases for single words, and 6 sessions to complete the phrase phases. Participant B required 18 sessions to complete all 3 auditory MTS phases for phrases. She required 20 sessions to complete the auditory MTS instruction for single words.

Participant C mastered all single word phases in a total of 27 sessions, and all phrase sessions in 9 sessions, while Participant D achieved criterion of all phrase phases in 16 sessions. However, it took Participant D 25 sessions to complete all single word auditory MTS phases.

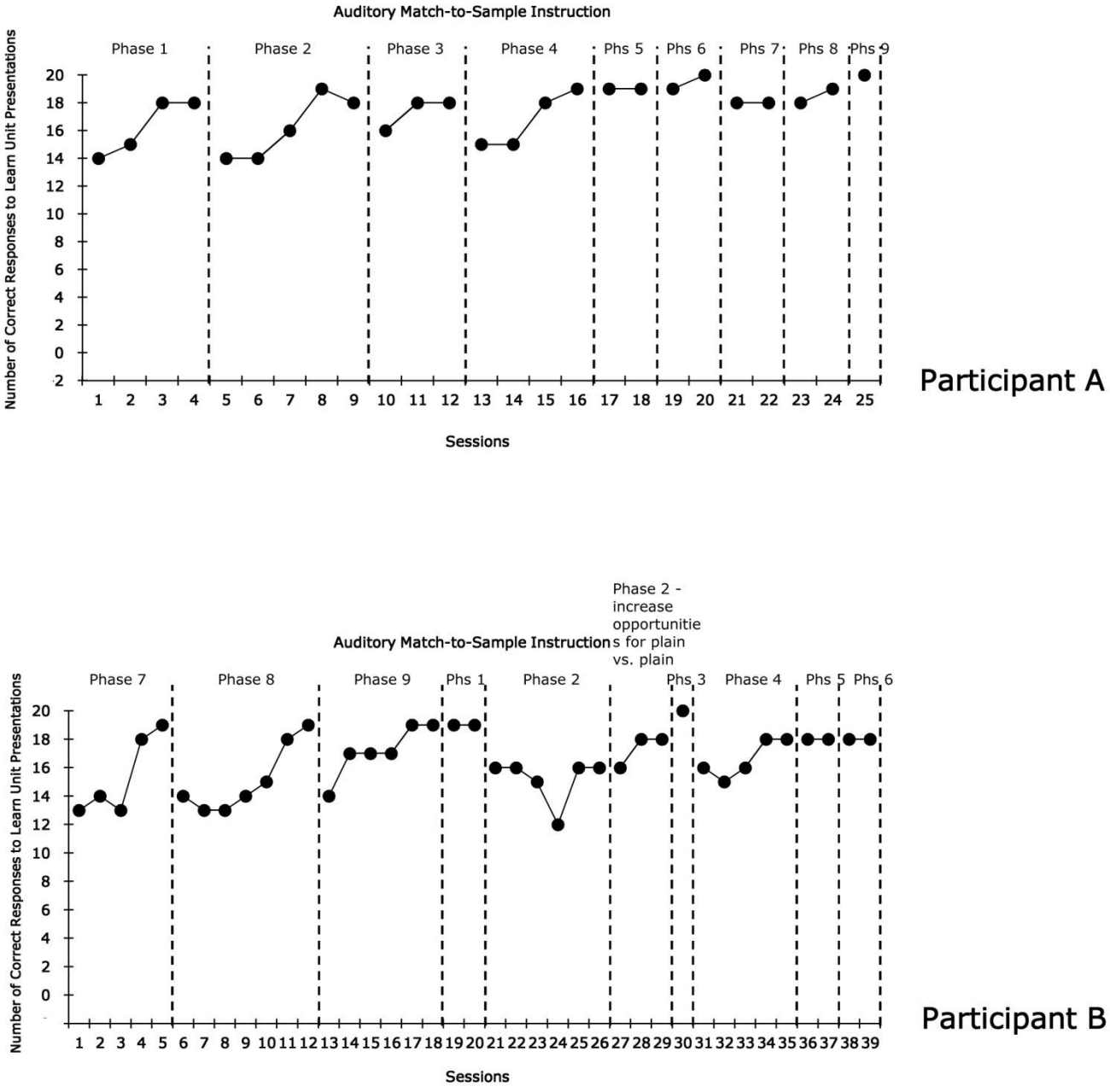

Figure 6. Number of correct responses emitted by Participants A and B during the advanced auditory MTS instruction.

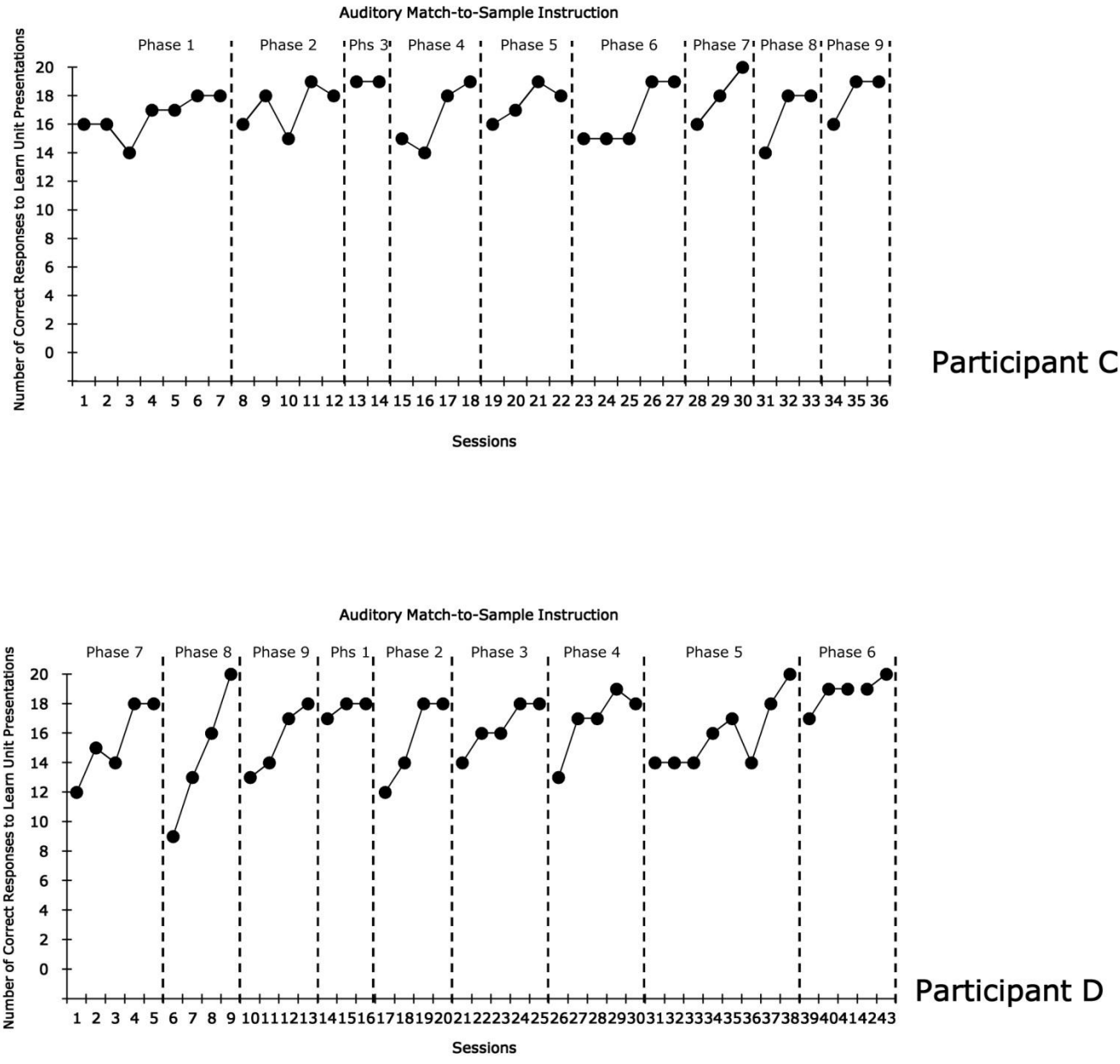

Figure 7. Number of correct responses emitted by Participants C and D during the advanced auditory MTS instruction.

The results of Experiment 1 showed that the advanced auditory MTS instruction was effective in the acquisition of advanced listener literacy for all participants. The advanced auditory MTS instruction also resulted in the emergence

of full Naming for Participants A and C. Participants B and D achieved a listener half of Naming through the auditory MTS instruction. Their untaught speaker responses (i.e., speaker half of Naming) also increased significantly. Participant B's correct tact and intraverbal responses increased from 15% to 65% and from 0% to 70%, respectively. Participant D's correct tact and intraverbal responses also increased from 0% to 75%. However, they did not achieve the criterion (i.e., 80% accuracy for both tact and intraverbal) to identify the emergence of speaker components of Naming. Moreover, the results also demonstrated that the advanced auditory MTS instruction increased participant's full echoic responses to 100 English words and 40 Korean novel sound words.

Discussion

The purpose of the current experiment was to test the effects of mastery of the advanced auditory MTS instruction on the emergence of advanced listener literacy, Naming, and the emission of participant's full echoic responses. The development of a listener repertoire is an essential component of effective learning (Chavez-Brown, 2005). Fluent listener repertoires allow the participant to learn correspondence between vocal instructions and non-verbal behaviors with fewer learn unit presentations. Listener literacy is also a prerequisite for acquiring educational objectives at a faster rate (Greer & Keohane, 2005). When listener literacy is in individual's repertoires, this cusp functions as the catalyst for students to acquire other behaviors in repertoire more effectively.

The data from post-auditory MTS probes showed that the participants were under the vocal antecedent stimulus control rather than visual distracter stimulus

control. Thus, the results support the investigations of Lee Park (2005), Chavez-Brown (2005), and Speckman-Collins, Lee Park, and Greer (2007) in which the auditory MTS instruction required the participant to listen to the target exemplar and match after hearing a positive and negative exemplar, which induced listener literacy.

Lee Park (2005) and Speckman-Collins, Lee Park, and Greer (2007) also demonstrated a functional relation between the mastery of the basic auditory MTS instruction and the emergence of the listener component of Naming with the participants who functioned on pre-listener and pre-speaker levels of verbal behavior. In this current study, however, I implemented advanced auditory MTS instruction which required more complicated and intensive auditory matching-to-sample response using more similar non-exemplars. I also tested the effects of mastery of the advanced auditory MTS instruction on both listener and speaker components of Naming. The participants in the current study functioned on more advanced listener and speaker verbal behavior levels. In the Naming probe session of Experiment 1, all participants emitted more correct responses to untaught verbal responses as the intervention phases progressed. Moreover, the results of all participants showed that the capability of matching sounds with sounds resulted in the increase of full echoic responses and the decrease of partial echoic responses and incorrect vocalizations. These findings were also consistent with Lee Park (2005), Chavez-Brown (2005), and Speckman-Collins, Lee Park, and Greer (2007).

Speckman-Collins, et. al. (2007) argued that the conditioned reinforcement of voices may be potential source of the listener components of Naming. Longano (2008) tested the effects of the stimulus-stimulus pairing procedure on the joining of listener

and speaker behavior and Naming. In this study, advanced auditory MTS instruction possibly provided the history of reinforcement that functioned to condition the adult voices as reinforcers for listening to speech (Greer, Pistoljevic, Cahill, & Du, 2011; Keohane, Luke, & Greer, 2008). The voices as conditioned reinforcers may result in the emergence of Naming, advanced listener literacy, and the emission of full echoic responses. Will the advanced auditory MTS instruction result in the emergence of listener literacy, speaker-as-own-listener cusps (i.e., Naming, say-do correspondence and self-talk), and increase in participant's full echoic responses? This experimental question was partially answered according to the data in Figures 1, 2, 3, and 4 in which (1) advanced listener literacy emerged across all participants, (2) full Naming emerged for Participants A and C as advanced auditory MTS instruction progressed, and (3) full echoic responses increased across all participants. However, Experiment 1 did not show the effect of the advanced auditory MTS instruction on the other two speaker-as-own-listener cusps (i.e., say-do correspondence and self-talk).

The improvements of Naming, listener literacy, and full echoics suggested that the conditioning effects would occur through the training sessions and that Naming was also induced through the conditioning effects of voices (Longano, 2008). Longano (2008) argued that the conditioning effects may result in the emergence of Naming. In Experiment 2, therefore, the experimenter conducted the probe session which could identify the degree of conditioned reinforcement for adult voices. In addition, it was hypothesized that the other speaker-as-own-listener cusps (e.g., self-talk and say-do correspondence) would emerge by the same source inducing Naming. Experiment 2 investigated the effects of mastery of the advanced auditory MTS

instruction on the three speaker-as-own-listener cusps: (1) self-talk, (2) say-do correspondence, and (3) Naming. In addition, the numbers of conversational units emitted in the non-instructional settings was measured since the individual should engage in the rotation of speaker and listener functions with others or himself as in self-talk.

Experiment 2 also systematically replicated the experimental procedures of Experiment 1 to test again the effects of mastery of the advanced auditory MTS instruction on the emergence of advanced listener literacy and the improvement of full echoic responses. In Experiment 1, due to the high number of Participant D's inexact echoic responses for three and four word phrases, the experimenter probed his full echoic responses to three and four word phrases. The results showed that his full echoic responses for three and four word phrases increased significantly after auditory MTS phases for phrases. Thus, Experiment 2 tested again the effects of mastery of the advanced auditory MTS instruction on the echoic responses for phrases and novel advanced English words with more participants.

Chapter III

EXPERIMENT II

Method

Participants

Three elementary school students with Autism Spectrum Disorders (ASD) or Attention Deficit Hyperactivity Disorder (ADHD) served as the participants for Experiment 2. They attended a self-contained classroom under the Comprehensive Application of Behavior Analysis to Schooling (CABAS®) model. The participants were selected since they emitted low numbers of correct responses to advanced listener literacy probes or low numbers of sequelics and conversational units.

Participant E was an eight-year-old female who functioned at the listener, speaker, early reader, and early writer levels of verbal behavior. Participant F was a seven-year-old male who functioned at the listener, speaker, early reader, and early writer levels of verbal behavior. Participant G was an eight-year-old male who functioned at the listener, speaker, early reader, and early writer revels of verbal behavior (see Table 10 and Table 11 for a complete description of all participants).

Table 10

Standardized test score of participants

Participant	Standard Scores
E- 8 year old Female Diagnosed with Autism	(Conducted in 2009) Expressive One-Word Picture Vocabulary Test - SS:58; <1% Receptive One-Word Picture Vocabulary Test - Total SS;63; 1% Test for Auditory Comprehension of Language-3 - Quotient 59; <1% - SS:6;%ile;9;AE:5.9
F- 7 year old Male Diagnosed with ADHD	(Conducted in 2010) Wechsler Intelligence Scale for Children -IV - Full Scale IQ 88; Perceptual Reasoning 86; Processing Speed 100; Verbal Comprehension 81; Working Memory 102 Developmental Test of Visual-Motor Integration - Total SS:77 Naglieri Nonverbal Ability Test - SS:91
G- 8 year old Male Diagnosed with Autism	(Conducted in 2009) Beery-Visual Motor Integration-V - SS:89 Core Language Score SS 94, 34%ile ; Expressive Vocabulary SS 11, 63%ile ; Grammatical Structures SS: 9 , 37%ile; Recalling Sentences SS 6, 9%ile; Sentence Structure SS 8, 25%ile; Expressive Word Classes SS 6, 9%ile; Receptive Word Classes SS 5, 5%ile Test of Pragmatic Language Total Test - SS: 80, 9%ile

Table 11

Verbal behavior levels of participants. O indicated that a cusp or capability is in a repertoire. X indicated that a cusp or capability is not in a repertoire.

Participant	Verbal Behavior Levels	Related Cusps or Capabilities		
			Prior to the Auditory MTS	After Mastery of Auditory MTS
E	Listener, Speaker, Early Reader(below-grade-level of reader), Early Writer(below-grade-level of writer)	Basic Listener Literacy	O	O
		Generalized Matching	O	O
		Conditioned reinforcement for voices	X	O
		Advanced Listener Literacy	X	O
		Listener Half Naming	O	O
		Full Naming	X	O
		Say-do in speaker-as-own listener function	X	O
		Self-talk	X	O

F	Listener, Speaker, Early Reader (below-grade-level of reader), Early Writer (below-grade-level of writer)	Basic Listener Literacy	O	O
		Generalized Matching	O	O
		Conditioned reinforcement for voices	X	X
		Advanced Listener Literacy	X	O
		Listener Half Naming	O	O
		Full Naming	X	X
		Say-do in speaker-as-own listener function	X	O
		Self-talk	X	O
G	Listener, Speaker, Early Reader(below-grade-level of reader), Early Writer(below-grade-level of writer)	Basic Listener Literacy	O	O
		Generalized Matching	O	O
		Conditioned reinforcement for voices	X	O
		Advanced Listener Literacy	X	O
		Listener Half Naming	X	O
		Full Naming	X	X
		Say-do in speaker-as-own listener function	X	X
		Self-talk	X	X

Setting

Experiment 2 was conducted in the same setting as used in Experiment 1 with minimal differences other than the additional dependent variables. First, Experiment 2 was conducted in a different school year after Experiment 1, and therefore, the classroom ratio was changed to 8 students: 1 teacher: 3 teaching assistants. Second, the participants used either a computer mouse or iPad® to emit responses during intervention sessions since they had fluent fine motor skills to use a computer mouse.

Materials

In the pre- and post-intervention probes for the Naming capability, the same Korean letters with contrived names were used as the stimuli. Please refer Experiment 1 for detailed stimuli (see Table 3). However, the experimenter conducted sessions on echoic responses using a different list of English words since all participants in Experiment 1 emitted more than 50% correct full echoic responses to the 100 English words in a pre-probe. A reinforcement history for the 100 English words could function as a possible ceiling effect. In Experiment 2, therefore, the experimenter presented 50 multisyllabic and uncommon words with which the participants did not have any instructional history (see Table 12). The same 40 Korean language words were used to test echoic responses. Please refer Experiment 1 for the full list of the target Korean language words (see Table 4).

During pre-and post-intervention advanced listener literacy probes, the experimenter systemically replicated the procedures of Experiment 1. Please refer to Experiment 1 for a detailed description of advanced listener literacy probe procedure.

Table 12

50 multisyllabic and uncommon words used during echoic probe sessions.

1. aspiration	26. methodology
2. auditory	27. nationalism
3. biology	28. neuroscience
4. behavioral	29. organization
5. capacity	30. oscillator
6. conditioning	31. phenomenon
7. diabetes	32. phonology
8. depreciate	33. quantitative
9. echolalia	34. qualitative
10. economics	35. radiation
11. formalities	36. retroactive
12. felicity	37. salivation
13. gastropathy	38. sensitivity
14. generation	39. tonality
15. homogeneous	40. transformation
16. hypotheses	41. university
17. inflectional	42. unconditional
18. invertebrate	43. vestibular
19. journalist	44. velocity
20. justifying	45. westernization
21. kinesthetic	46. welfare
22. kyanite	47. xerinae
23. locomotion	48. yerbamate
24. laboratory	49. zincography
25. molecular	50. zeppelin

In Experiment 2, prior to and following the intervention, all the participants were presented with a three or four word phrase to which they were required to emit echoic responses. The list of 20 different phrases was the same as the one from Experiment 1 (see Table 6).

During pre-and post-intervention voice conditioning probes, a voice conditioning Flash® program was presented. The program displayed a screen containing one circular red button at the center of the screen. When the participant followed and kept a pointing arrow on the red button, pre-recorded stories was played.

During the intervention sessions, materials included the auditory MTS program on the computer, computer speakers, and a computer mouse. During all pre- post- and intervention sessions, the experimenter used the same computer generated data sheets, graphs, and black pen to record data.

Procedure

Design

A time-lagged multiple probe across participants design was implemented in Experiment 2 (Johnston & Pennypacker, 1993). The experimenter systemically replicated the same experimental procedure as used in Experiment 1. However, Experiment 2 did not follow a counterbalanced experimental sequence since no differences were observed between the sequence of the implementation across the components of the auditory MTS instruction and the numbers of correct responses in the post-probes in Experiment 1. Thus, all participants started the intervention by matching single words. Subsequently, matching phrases and matching multisyllabic and uncommon words were introduced. Each learn unit was delivered in the same way as used in Experiment 1.

The probe sessions were time-lagged across participants. A pre-probe was conducted across all participants - measuring unconsequated correct responses to advanced listener literacy probe trials, the untaught topography for Set 1 words in Naming probes, the numbers of unconsequated correct responses to say-do correspondence probe trials, the numbers of contextually appropriate self-talk during a toy play setting, and the numbers of full echoic responses to 50 multisyllabic and uncommon words and 40 Korean words. Prior to the implementation of the auditory

MTS instruction, the second pre-probe was conducted. Following the mastery of each auditory MTS training type (e.g., single words, phrases, and multisyllabic/uncommon words), the experimenter conducted post-probe sessions.

In addition, the numbers of conversational units and sequelics emitted during a peer play setting was measured. After the participant completed all the components of the auditory MTS instruction, the experimenter conducted probe sessions to identify the emergence of full Naming for Set 1 and Set 2.

Criterion for each auditory MTS phase was determined at 90% accuracy across two consecutive sessions or 100% accuracy at the first session of a target phase. Once the participant achieved criterion for each phase, the experimenter implemented the next phase. The auditory MTS instruction continued until the participants completed all the phases consisting of single words, phrases, or multisyllabic/uncommon words. After the participants completed all phases of the single word, phrase, or multisyllabic and uncommon phases, the experimenter conducted post-intervention probe sessions which were identical to the pre-intervention sessions. After these post-probe sessions, the next type of the auditory MTS instruction was introduced, which they had not mastered before (single words, phrases, or multisyllabic/uncommon words).

After Participant E completed his first type of the auditory MTS program (i.e., single words) and participated in the post-intervention probe sessions, Participant F began the intervention phase with single words. After Participant F completed his first type of the auditory MTS program, Participant G started her first type of the auditory MTS program. Please see Table 13.

Table 13

Experimental sequence of Experiment 2

Participant	Sequence of Probes or Interventions									
E	Pre-auditory MTS probe	2nd Pre-auditory MTS probe	Auditory MTS instruction for single words	Post-single word set probe	Auditory MTS instruction for phrases	Post-phrase set probe	Auditory MTS instruction for multisyllabic and uncommon words	Post-auditory MTS probe		
F	Pre-auditory MTS probe		2nd Pre-auditory MTS probe	Auditory MTS instruction for single words	Post-single word set probe	Auditory MTS instruction for phrases	Post-phrase set probe	Auditory MTS instruction for multisyllabic and uncommon words	Post-auditory MTS probe	
G	Pre-auditory MTS probe			2nd Pre-auditory MTS probe	Auditory MTS instruction for single words	Post-single word set probe	Auditory MTS instruction for phrases	Post-phrase set probe	Auditory MTS instruction for multisyllabic and uncommon word	Post-auditory MTS probe

Independent Variable: Mastery of Advanced Auditory MTS Instruction

The independent variable in Experiment 2 was the same as used in Experiment 1 with several changes. In Experiment 2, the advanced auditory MTS instruction involved four additional phases (Phase 10 through 13) that included matching multisyllabic and uncommon words with which the participants were highly unlikely to have an instructional history. In Experiment 2, the advanced auditory MTS consisted of three types of training procedures; (1) six phases (Phase 1 through 6) of matching single words, (2) three phases (Phase 7 through 9) of matching phrases, and (3) four phases (Phase 10 through 13) of matching multisyllabic and uncommon words. Please refer Table 14 for the additional four phases.

Table 14

Multisyllabic and uncommon word used during the advanced auditory MTS instruction.

Sets	Phases	Stimuli
Single Words	Phase 1	Please see Table 8.
	Phase 2	
	Phase 3	
	Phase 4	
	Phase 5	
	Phase 6	
Phrases	Phase 7	
	Phase 8	
	Phase 9	
Multisyllabic and Uncommon Words	Phase 10	biological, aboriginal, balletomania, calamine, defibrate, emollient, facultative, fasciculation, galactose, headquarters
	Phase 11	immunization, impulsivity, juvenile, kilogram, labyrinth, malleability, management, occupational, occurrence, tendentious
	Phase 12	lamella, laparoscope, maxillofacial, olfaction, palatine, palpability, population, randomize, receptor, regenerate
	Phase 13	measurement, obstruction, octosyllabic, pandiculation, paramountcy, quicksilver, questionnaire, radiation, thermoplastic, transaction

Dependent Variable

The dependent variables in Experiment 2 were (1) advanced listener literacy, (2) the emergence of Naming, (3) the emergence of contextually appropriate self-talk play, (4) the emergence of say-do correspondence during toy play, (5) conversational units and sequelics emitted in a peer play setting during toy play, (6) full echoic responses emitted during probes, and (7) the degree of conditioned reinforcement for adult voices.

Advanced listener literacy and Naming were tested using the same procedures as used in Experiment 1.

The experimenter also measured the numbers of (1) occurrences of contextually functional self-talk, (2) conversational units, (3) sequelics, (4) say-do correspondence, (5) tacts, and (6) mands emitted in a free play setting probe sessions. The participant participated in group-peer and isolated-individual play probe sessions. During a group-peer play probe session, the target participant and two peers played with approximately 20 anthropomorphic and conditioned toys for 5 minutes. During an isolated-individual play probe, only one target participant played with approximately 20 anthropomorphic and conditioned toys for 5 minutes.

A contextually functional self-talk instance was defined as either conversational units or sequelics contextually related to the toy play which consisted of self-verbal exchanges where the participant played the roles of both speaker and listener. Sequelics were defined as speaker-as-own-listener responses which occur as exchanges between two distinct self-speaking voices emitted by the individual or as part of one verbal chain. For example, when the participant said “Hey, Clifford! Let’s

go to the second floor" and then also said "Oh, sure. Let's go." in the presence of a Clifford toy and Little People house, it was determined that he emitted one instance of sequelic functional self-talking. Please refer to Figure 8.

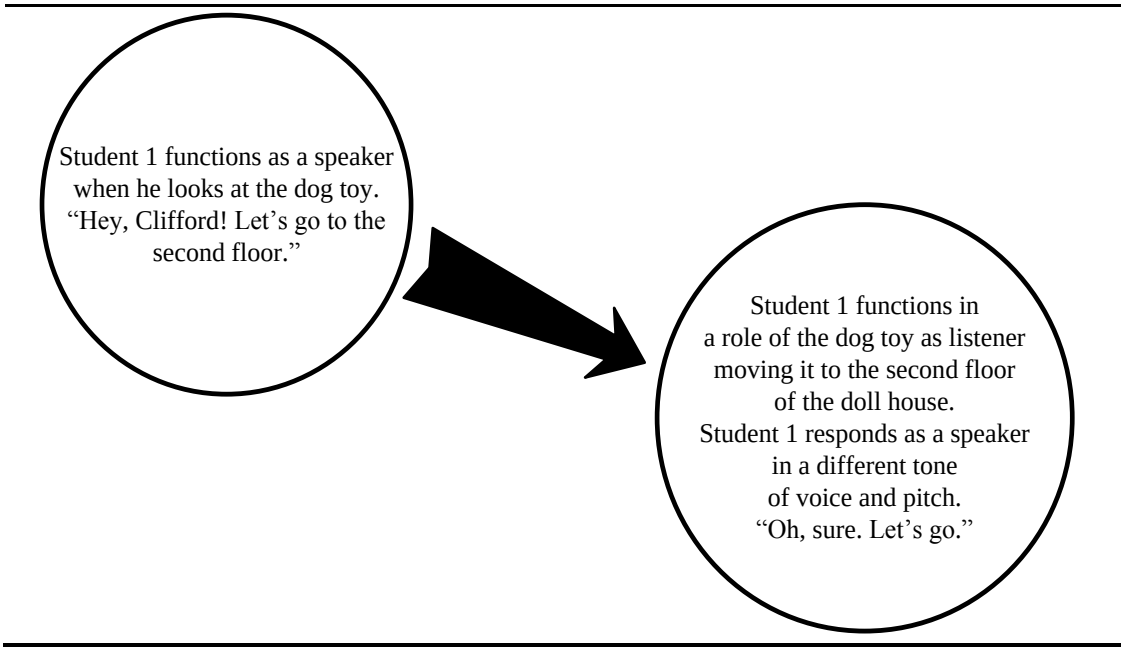

Figure 8. An instance of a sequelic in a self-talk (Greer & Ross, 2008).

The numbers of instances of contextually functional conversational units was also measured during a peer and individual play settings. A conversational unit is defined as a verbal relation comprised of interlocking intraverbals between at least two different individuals or two different verbal behavior functional roles during which each individual role functions and is reinforced as both a listener and a speaker in a rotated episode. For example, a speaker, Student 1, said to Student 2, "Hey, Chris. What are you doing?"; a listener, Student 2, responded as a speaker to a listener, Student 1, "I am playing on Nintendo DS. Do you want to play together?"; and then a listener, Student 1 responded as a speaker to a listener, Student 1, "Sure. I want to."

That is, both Student 1 and 2 rotated both speaker and listener functions in a conversational unit. In a self-talk episode, the participant said to himself/herself, "Hey, Clifford! Let's go to the second floor." in a speaker role; the same participant responded to himself/herself, "Oh, sure. Let's go." in listener and speaker roles; and then he/she responded to himself/herself again, "Thank you, Clifford." in listener and speaker roles. This episode was also determined that he emitted one instance of a conversational unit. Please see Figure 9 and 10.

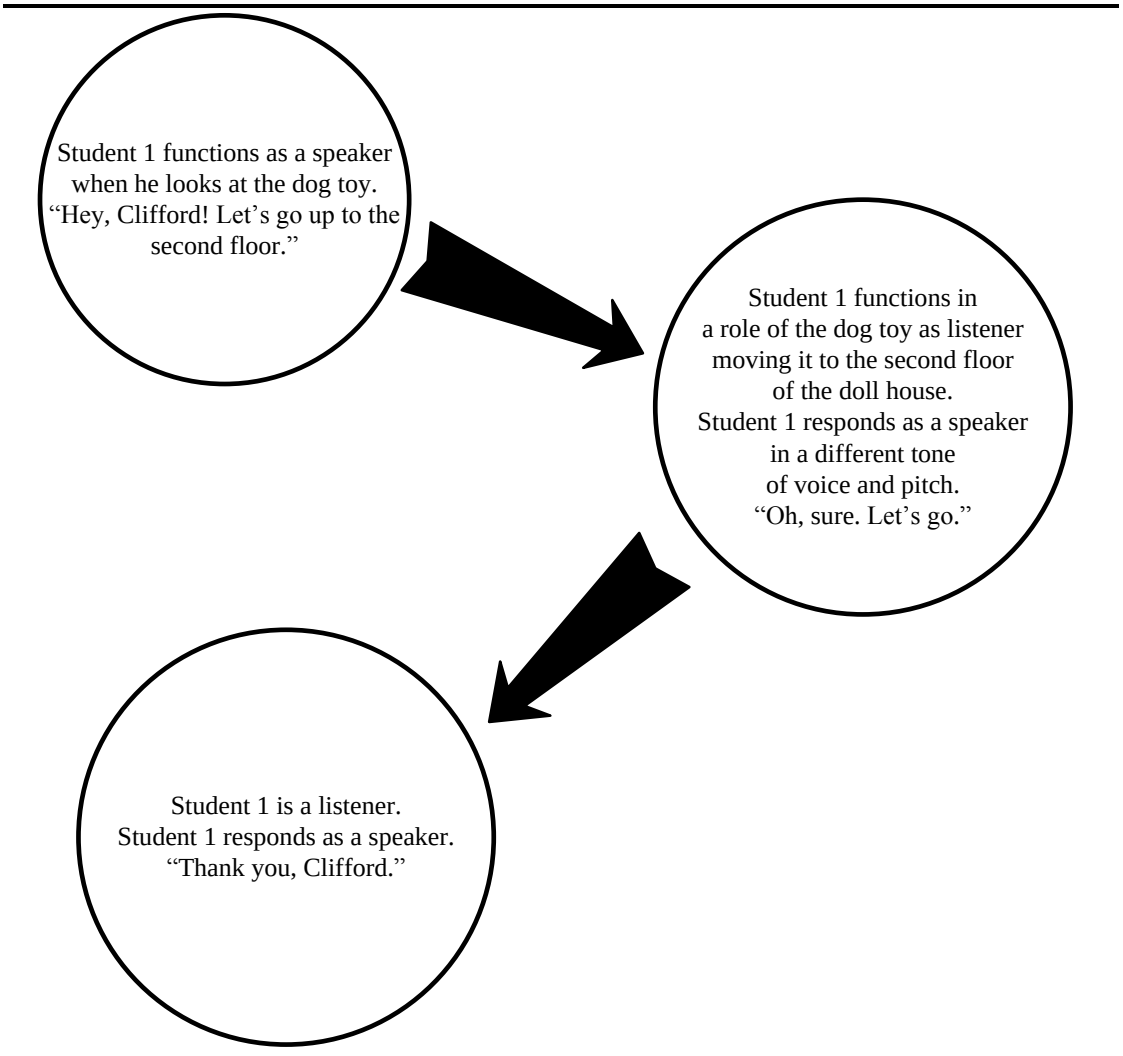

Figure 9. An instance of a conversational unit in a self-talk (Greer & Ross, 2008).

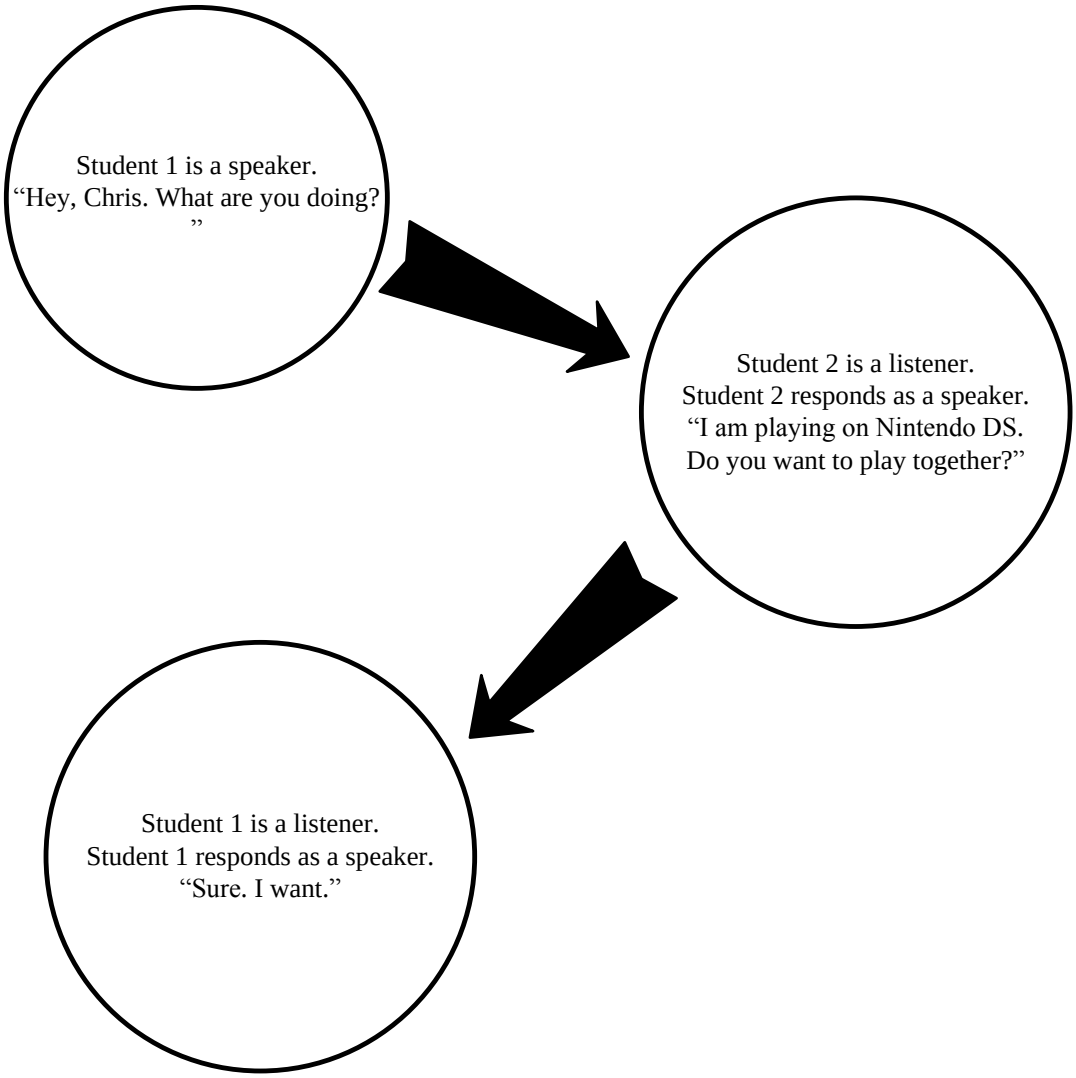

Figure 10. An instance of a conversational unit between two different individuals (Greer & Ross, 2008).

The numbers of instances of correspondence between saying and doing was also measured in a free play setting probe session. Say-do correspondence was defined the one-to-one correspondence between individual's response as a listener and his/her own verbal behaviors (Greer, & Speckman, 2009). For example, in a say-do correspondence, the participant functioned in a role of speaker to Clifford with "Hey, Clifford! Let's go to the second floor." then responded to the verbal direction as listener by moving Clifford to the second floor of the doll house.

Additionally, the numbers of tacts and mands emitted in a free play setting probe session was also measured. A tact was defined as a vocal verbal operant that is under the control of non-verbal antecedents and reinforced by generalized reinforcement (Greer, 2002). For example, if the participant said "this is a farm truck!" looking at a farm truck, this verbal behavior was measured as a tact. A mand was defined as a verbal operant that is under the control of non-verbal antecedents and in which the response is reinforced by a characteristic consequence. For example, if the participant said "Oh! Please stop, Yostas!" in an anthropomorphic toy play, this verbal behavior was measured as a mand.

The numbers of echoic responses was also measured in the same way as used in Experiment 1. However, in Experiment 2, multisyllabic and uncommon words were used to measure participants' full echoic responses to English words since they did not have any instructional history for those words. Due to the participants' inexact echoic responses for three and four word phrases, the experimenter measured the numbers of full echoic responses to three and four word phrases for all the participants in Experiment 2.

Also, probes were conducted to identify the degree of conditioned reinforcement for adult voices prior to and after the completion of each set of the advanced auditory MTS instruction (Keohane, Pereira-Delgado, & Greer, 2009; Greer, Pistoljevic, Cahill, & Du, 2011). During pre- and post-intervention voice conditioning probes, a voice conditioning Flash® program was presented. The program displayed a screen containing one circular red button at the center of the screen. When the participant followed and kept a pointing arrow on the red button, pre-recorded stories

were played. If the participant followed a pointing arrow out of the red button area, the computer program immediately stopped the prerecorded stories. If the participant did not place her/his hand on the mouse, the experimenter also stopped the prerecorded stories. That is, the correct response was defined as keeping a pointing arrow on the red button displayed on the computer screen, and listening to prerecorded stories without stereotypy. One probe session consisted of continuous 60 five second intervals (e.g., 5 minutes). Whole-interval recording was employed to record the target behavior. Partial-interval recording was used to record any other undesired behaviors (e.g., stereotypy) the participant emitted.

Data Collection

During pre- and post- intervention probe sessions, echoic responses to both English, and Korean words were measured in the same manner as used in Experiment 1. During pre-and post-intervention probes for English phrases, and advanced listener literacy, data were recorded with a plus (+) for a correct response or a minus (-) for an incorrect response.

During pre- and post- intervention probes for verbal behaviors emitted during group-peer and isolated-individual play settings, the participant's free play was video-recorded for five minutes for each setting (i.e., ten minutes in a total). The experimenter transcribed verbal behaviors that the participant emitted during a free play session. According the script and movie clip, instances of functional self-talk, conversational units, sequelics, say-do correspondences, tacts, and mands were measured.

During all auditory MTS sessions, data were recorded with a plus (+) for a correct matching response or a minus (-) for an incorrect matching response.

During pre- and post-intervention voice conditioning probes, the participant was required to move and keep a pointing arrow on the red button for listening pre-recorded stories. One probe session had 60 five second intervals. Whole-interval recording was employed to record the target behavior. Partial-interval recording was used to record undesired behaviors (e.g., stereotypy) undesired behaviors other than the target behavior. A plus (+) sign was recorded when the participant was keeping a pointing arrow on the red button displayed on the computer screen, and listening to prerecorded stories for a five second whole interval. A minus (-) sign was recorded for incorrect responses.

Interobserver Agreement

Interobserver agreement (IOA) was conducted in the same way as used in Experiment 1. The Teacher Performance Rate and Accuracy (TPRA) scale in a situation or from video recordings to ensure fidelity of treatment and measurement accuracy for participant responses (Ingham & Greer, 1992). Interobserver agreement was calculated by dividing the numbers of point-to-point agreements and disagreement by the total number of agreements plus disagreements and multiplied by 100% (Johnston & Pennypacker, 1993).

Advanced Listener Literacy. For the advanced listener literacy probe sessions for Participant E, interobserver agreement was conducted for 80% of the probe sessions and 100% agreement was calculated. For Participant F, interobserver agreement was conducted for 100% of probe sessions at 100% agreement. For

Participant G, interobserver agreement was conducted for 80% of the probe sessions and 100% agreement was calculated. Please see Table15.

Table 15

Mean interobserver agreement for the advanced listener literacy probes for Participants E, F, and G

	Participant E	Participant F	Participant G
Percent of Probe Sessions	80%	100%	80%
Mean Agreement for Probe Sessions	100%	100%	100%
Range of Agreement for Probe Sessions	No range	No range	No range

Naming. For the Naming probe session for Participant E, interobserver agreement was conducted for 100% of probe sessions at 100% agreement. For Participant F, interobserver agreement was conducted for 100% of the probe sessions and 99% agreement was calculated. For Participant F, interobserver agreement ranged from 95% to 100%. For Participant G, interobserver agreement was conducted for 83% of probe sessions at 100% agreement. Interobserver agreement for the Naming probes for Participants E, F, and G is shown in Table 16.

Table 16

Mean interobserver agreement for the Naming probes for Participants E, F, and G

	Participant E	Participant F	Participant G
Percent of Probe Sessions	100%	100%	83%
Mean Agreement for Probe Sessions	100%	99%	100%
Range of Agreement for Probe Sessions	No range	96% – 100%	No range

Self-talk, Conversational Units, Sequelics, Say-do. For the self-talk, conversational units, sequelics, say-do probe session for Participant E, interobserver agreement was conducted for 80% of probe sessions at 99% agreement. For Participant E, interobserver agreement ranged from 96% to 100%. For Participant F, interobserver agreement was conducted for 100% of the probe sessions at 99% agreement. For Participant G, for 80% of probe sessions at 98% agreement. For Participant E, interobserver agreement ranged from 95% to 100%. Interobserver agreement for the self-talk, conversational units, sequelics, say-do probes for Participants E, F, and G is shown in Table 17.

Table 17

Mean interobserver agreement for the self-talk, conversational units, sequelics, say-do probes for Participants E, F, and G

	Participant E	Participant F	Participant G
Percent of Probe Sessions	80%	100%	80%
Mean Agreement for Probe Sessions	99%	100%	98%
Range of Agreement for Probe Sessions	96% – 100%	No range	95% – 100%

Echoic Responses to Korean Novel Sounds. For the Korean novel word echoic probe session for Participant E, interobserver agreement was conducted for 80% of probe sessions at 92% agreement. For Participant E, interobserver agreement ranged from 85% to 100%. For Participant F, interobserver agreement was conducted for 100%

of probe sessions at 96% agreement. For Participant F, interobserver agreement ranged from 88% to 100%. For Participant G, interobserver agreement was conducted for 80% of probe sessions at 100% agreement. Interobserver agreement for the Korean novel word echoic probes for Participants E, F, and G is shown in Table 18.

Table 18

Mean interobserver agreement for the Korean novel word echoic probes for Participants E, F, and G

	Participant E	Participant F	Participant G
Percent of Probe Sessions	80%	100%	80%
Mean Agreement for Probe Sessions	92%	96%	100%
Range of Agreement for Probe Sessions	85% – 100%	88% – 100%	No range

Echoic Responses to English Words. For the multisyllabic and uncommon word echoic probe session for Participant E, interobserver agreement was conducted for 80% of probe sessions at 96% agreement. For Participant E, interobserver agreement ranged from 86% to 100%. For Participant F, interobserver agreement was conducted for 100% of probe sessions at 98% agreement. For Participant F, interobserver agreement ranged from 92% to 100%. For Participant G, interobserver agreement was conducted for 80% of probe sessions at 96% agreement. For Participant G, interobserver agreement ranged from 90% to 100%. Please see Table 19.

Table 19

Mean interobserver agreement for the English multisyllabic and uncommon echoic probes for Participants E, F, and G

	Participant E	Participant F	Participant G
Percent of Probe Sessions	80%	100%	80%
Mean Agreement for Probe Sessions	96%	98%	96%
Range of Agreement for Probe Sessions	86% – 100%	92% – 100%	90% – 100%

Echoic Responses to Phrases. For the phrase echoic probe session for Participant E, interobserver agreement was conducted for 80% of probe sessions at 99% agreement. For Participant E, interobserver agreement ranged from 94% to 100%. For Participant F, interobserver agreement was conducted for 100% of probe sessions at 100% agreement. For Participant G, interobserver agreement was conducted for 80% of probe sessions at 98% agreement. For Participant E, interobserver agreement ranged from 95% to 100%. Interobserver agreement for the phrase echoic probes for Participants E, F, and G is shown in Table 20

Table 20

Mean interobserver agreement for the phrase echoic probes for Participants E, F, and G

	Participant E	Participant F	Participant G
Percent of Probe Sessions	80%	100%	80%
Mean Agreement for Probe Sessions	99%	100%	98%
Range of Agreement for Probe Sessions	94% – 100%	No range	95% – 100%

Conditioned Reinforcement for Adult Voices. For the voice conditioning probe session for Participant E, interobserver agreement was conducted for 80% of probe sessions at 100% agreement. For Participants F and G, interobserver agreement was conducted for 100% of probe sessions at 100% agreement. Interobserver agreement for the voice conditioning probes for Participants E, F, and G is shown in Table 21.

Table 21

Mean interobserver agreement for the voice conditioning probes for Participants E, F, and G

	Participant E	Participant F	Participant G
Percent of Probe Sessions	80%	100%	100%
Mean Agreement for Probe Sessions	100%	100%	100%
Range of Agreement for Probe Sessions	No range	No range	No range

Independent Variable. Interobserver agreement was also conducted for the advanced auditory MTS instructional sessions. Interobserver agreement was calculated for 61% of intervention sessions for Participant E at 100% agreement. Interobserver agreement was calculated for 40% of intervention sessions for Participant F and was 100%. Interobserver agreement was calculated for 42% of intervention sessions for Participant G at 100% agreement. Interobserver agreement for the independent variable for Participants E, F, and G is shown in Table 22.

Table 22

Mean interobserver agreement for the independent variable for Participants E, F, and G

	Participant E	Participant F	Participant G
Percent of advanced auditory MTS instructional sessions	61%	40%	42%
Mean Agreement for Probe Sessions	100%	100%	100%
Range of Agreement for Probe Sessions	No range	No range	No range

Results

Advanced Listener Literacy. Figure 11 shows the numbers of unconsequated correct response to the advanced listener literacy probe trials in which a vocal direction was presented with a visual distracter prompt. The numbers of correct responses significantly increased across all the participants. Participant E emitted 13 correct responses out of 20 probe trials in both Pre-probe 1 and Pre-probe 2. Following completion of the auditory MTS instruction, however, her correct responses increased to 19. Participant F's correct responses also increased from 13 to 20 after a single word training set of the advanced auditory MTS phases and his correct responses maintained across the next post-probe sessions. Participant G emitted 3 and 2 correct responses in Pre-probe 1 and Pre-probe 2, respectively. After mastery of the auditory MTS instruction, he emitted 17 correct responses.

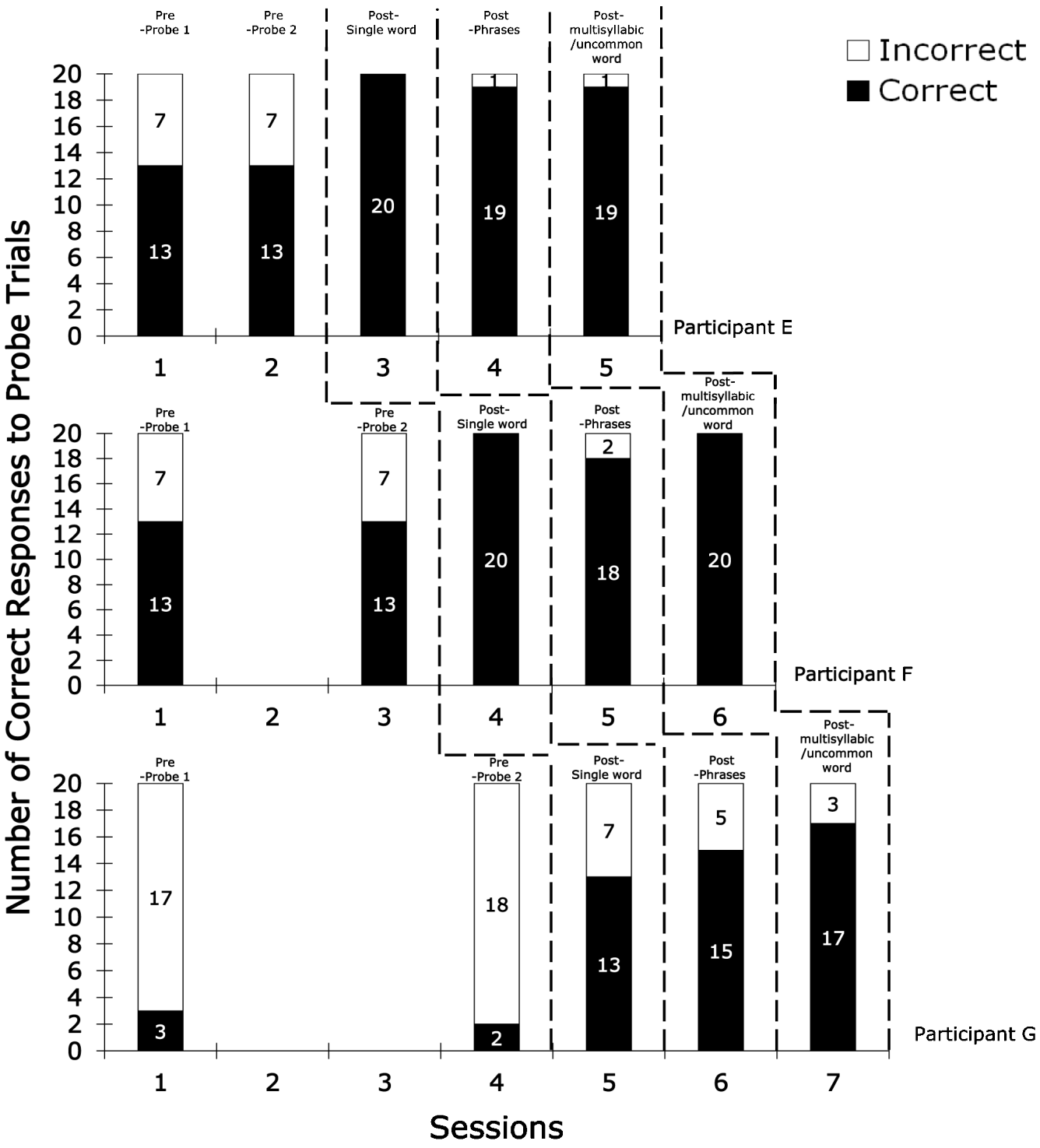

Figure 11. Number of correct responses to probe trials for 20 vocal directions which were simultaneously presented with a visual distracter prompt for Participants E, F, and G.

Naming. Figure 12 shows the numbers of participants' correct responses to the untaught listener or speaker responses to the stimuli sets following the mastery of the matching responses. In Pre-probe 1 and Pre-probe 2, Participant E emitted 15 and 16 point-to responses (i.e., listener responses) to Naming probe stimuli Set 1, respectively. In both pre-probe sessions, she did not emit tact responses and intraverbal responses to Naming probe stimuli Set 1. In both pre-probe sessions, Participant F emitted 18 point-to responses, no tact responses and no intraverbal responses to Naming probe stimuli Set 1. In Pre-probe 1 and Pre-probe 2, Participant G emitted 15 and 13 point-to responses to Naming probe stimuli Set 1, respectively. He did not emit tact responses and no intraverbal responses to Naming probe stimuli Set 1.

Following the mastery of the auditory MTS instruction, the untaught listener or speaker responses increased across all the participants. Participant E's correct responses increased to 19 point-to responses, 17 tact responses, and 18 intraverbal responses to Set 1. After this participant met criterion on all auditory MTS phases, she emitted 100% correct responses across all untaught responses to a novel set of stimuli, Set 2. Following the mastery of the advanced auditory MTS instruction, Participant F also emitted more correct responses for untaught responses: 19 point-to, 15 tact, and 17 intraverbal responses to Set 1. After mastering all auditory MTS sessions, Participant F emitted 18 correct point responses, 15 tact and 10 intraverbal responses to a novel set of stimuli. Participant G's correct responses also increased to 18 point-to, 15 tact, and 10 intraverbal responses. After the completion of the auditory

MTS instruction, he emitted 18 correct point responses, 10 tact and 10 intraverbal responses to a novel set of stimuli.

Therefore, Participant E acquired full Naming through the advanced auditory MTS instruction. Participant F's correct untaught listener and speaker responses increased significantly. Participant G achieved a listener half of Naming which had not been in his repertoire prior to the advanced auditory MTS instruction. However, Participant F and G did not achieve the criterion for the emergence of full Naming which was set at 80% correct response across both listener and speaker responses.

Self-talk, Conversational Units, and Sequelics. Figure 13 shows the numbers of conversational units, sequelics, self-talk, tacts, and mands emitted in a free play setting probe session. In Pre-probe 1 and Pre-probe 2, Participant E emitted 6 and 5 self-talk, respectively. Her contextually functional instances of self-talk increased to 54 following the mastery of the auditory MTS instruction. Her conversational units in self-talk also increased from 2 to 22 through the auditory MTS instruction. In Pre-probe 1 and 2, she emitted 4 and 3 sequelics, respectively. Through the auditory MTS instruction, her sequelics also increased to 19. Participant F emitted 1 self-talk, 1 sequelic, and no conversational units in Pre-probe 1. Following the mastery of the auditory MTS instruction, he emitted 11 self-talk, 7 sequelics, and 6 conversational units. Participant G emitted 1 self-talk in both Pre-probe 1 and Pre-probe 2. He emitted 1 sequelic and no conversational unit in Pre-probe 1. He emitted 1 conversational unit and no sequelic in Pre-probe 2. In the post-intervention probe sessions, he did not show considerable improvement for self-talk, conversational units, and sequelics.

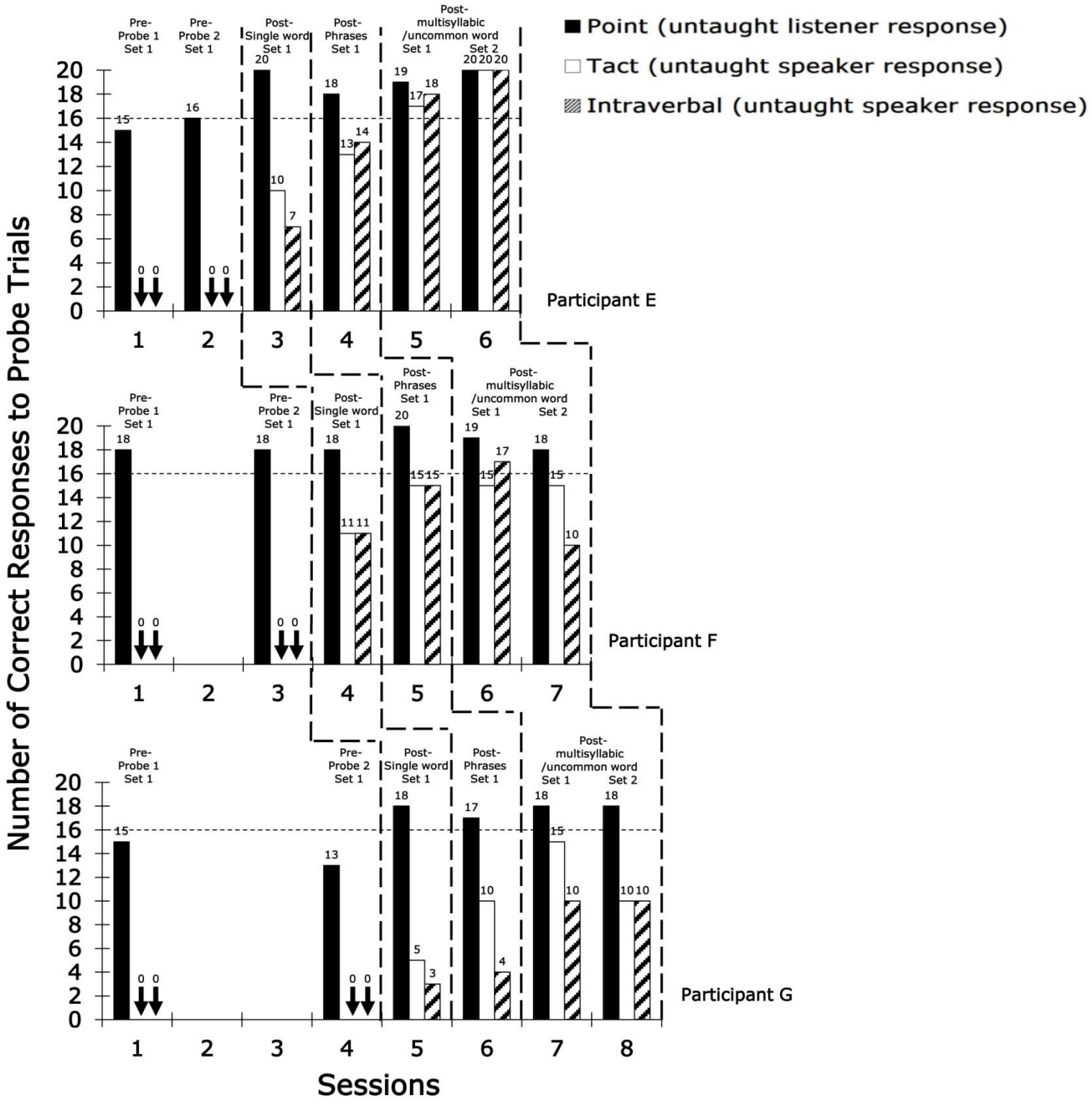

Figure 12. Number of correct untaught listener and speaker responses to 2D stimuli for Participants E, F, and G.

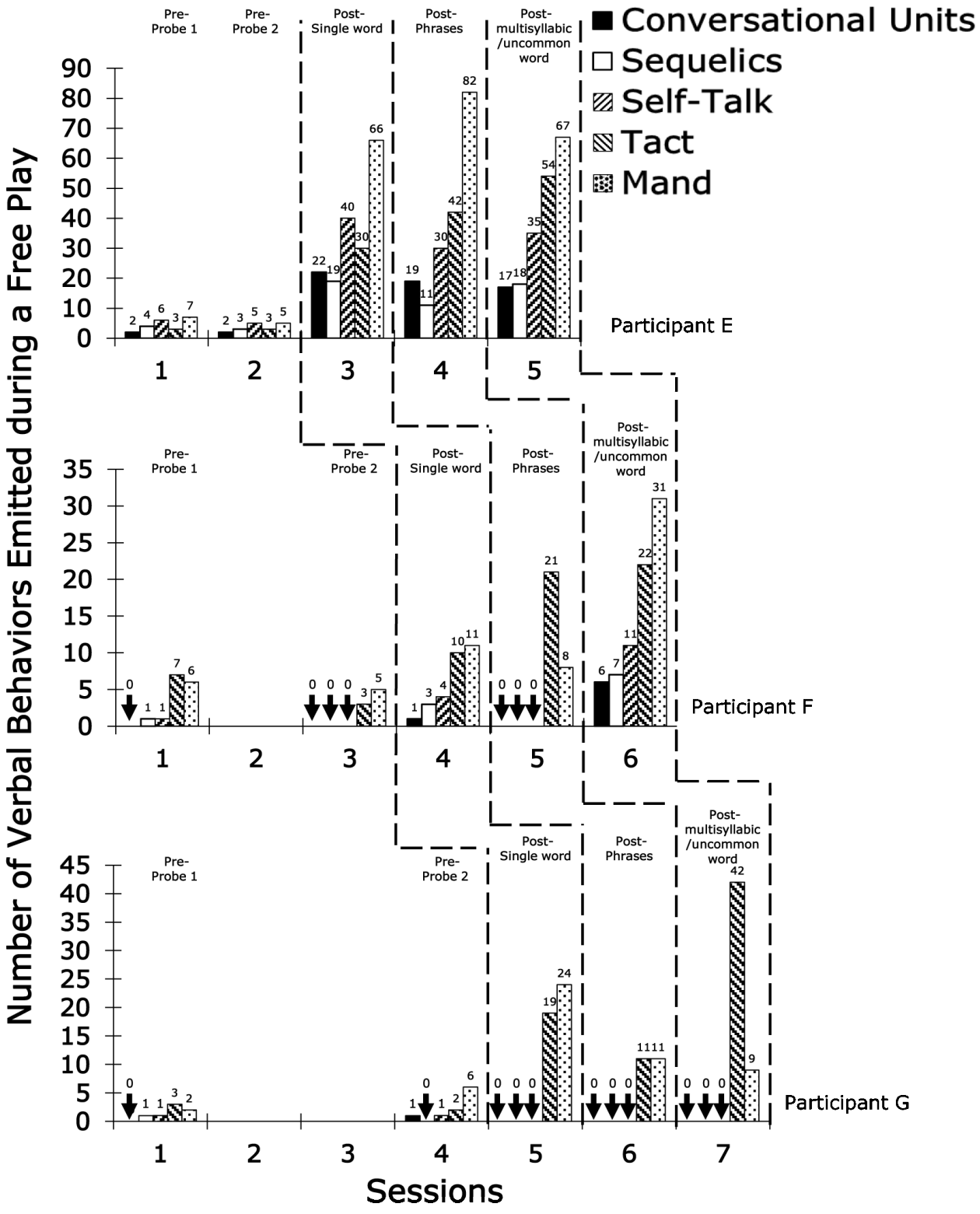

Figure 13. Number of conversational units, sequelics, self-talk, tacts, and mands emitted by Participants E, F and G during the group and individual free play probes.

Additionally, the numbers of tacts and mands emitted in a free play setting probe session was also measured. Participant E emitted 3 tacts in both pre-probes. In Pre-probe 1 and Pre-probe 2, she emitted 7 and 5 mands, respectively. After completion of the auditory MTS instruction, her tacts increased to 54. Following the mastery of one set of the phrases sessions, her mands increased to 82. Participant F's tacts and mands also increased. In Pre-probe 1 and Pre-probe 2, he emitted 7 and 3 tacts, respectively. He emitted 6 and 5 tacts in the pre-probes.

After the mastery of the auditory MTS instruction, his tacts and mands significantly increased to 22 tacts and 31 mands. Participant G emitted 3 and 2 tacts in Pre-probe 1 and Pre-probe 2. He emitted 2 and 6 mands in the pre-probes. However, his tacts increased to 42 after the mastery of the auditory MTS instruction. He emitted 24 mands after completion of one set of the single word matching sessions.

Say-Do Correspondence. Figure 14 shows the numbers of correspondences between saying and doing emitted in a free play setting probe session. Participant E emitted no say-do correspondences in both pre-probe sessions. However, she emitted 15 say-do correspondences following the mastery of one set of the single word matching sessions. Her say-do correspondences maintained across next post-probe sessions. Participant F emitted 1 and no say-do correspondence in Pre-probe 1 and 2, respectively. After completion of the auditory MTS instruction, his say-do correspondences increased to 10. Participant G did not show considerable improvement for say-do correspondences.

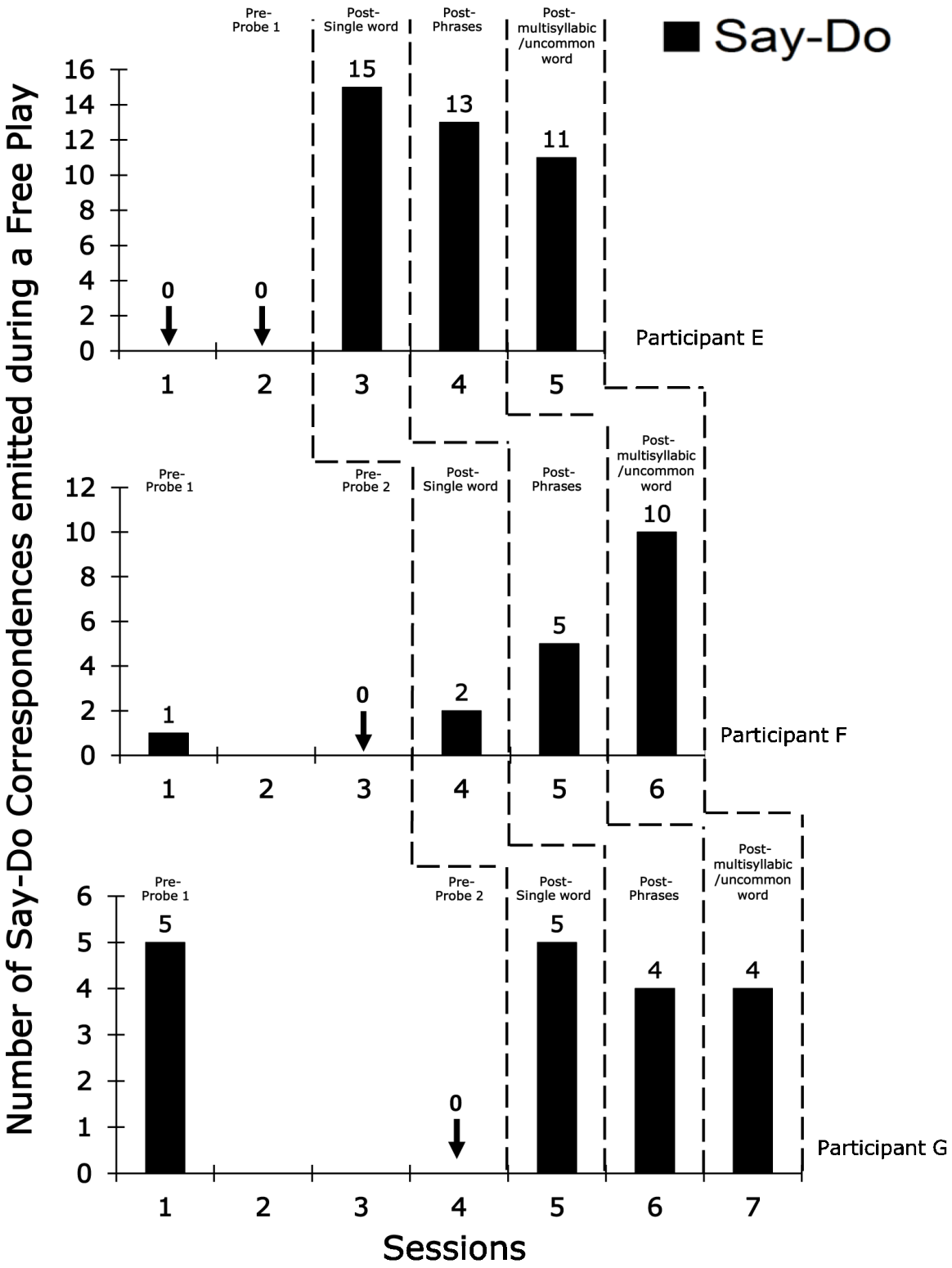

Figure 14. Number of say-do correspondences emitted by Participants E, F and G during the group and individual free play probes.

Echoic Responses to Korean Novel Sounds. Figure 15 shows the numbers of full and partial echoic to 40 Korean novel sound words. Participant F emitted 16 and 17 full echoic responses in Pre-probe 1 and 2, respectively. After mastering all auditory MTS sessions, her full echoic responses increased to 33 whereas her particle echoic responses decreased to 7. No incorrect vocalizations were observed. Participant F emitted 15 full echoic responses and 25 partial echoic responses in both pre-probe sessions. Following the mastery of all auditory MTS sessions, his full echoic responses increased to 32 whereas his partial echoic responses decreased to 8. Participant G's full echoic responses also increased. He emitted 17 and 15 full echoic responses in Pre-probe 1 and 2, respectively. After completion of all auditory MTS instruction, his full echoic responses significantly increased to 37.

Echoic Responses to English Words. Figure 16 shows participant's full, partial echoic responses, and vocalizations to 50 multisyllabic and uncommon words. Those were not trained through the auditory MTS instruction. Through the auditory MTS instruction, Participant E's full echoic responses increased from 18 to 42. Participant F emitted 20 and 22 full echoic responses in Pre-probe 1 and 2, respectively. His full echoic responses increased to 44, following the mastery of the auditory MTS instruction. Participant G's full echoic responses also increased from 33 to 49 whereas his partial echoic decreased from 18 to 1.

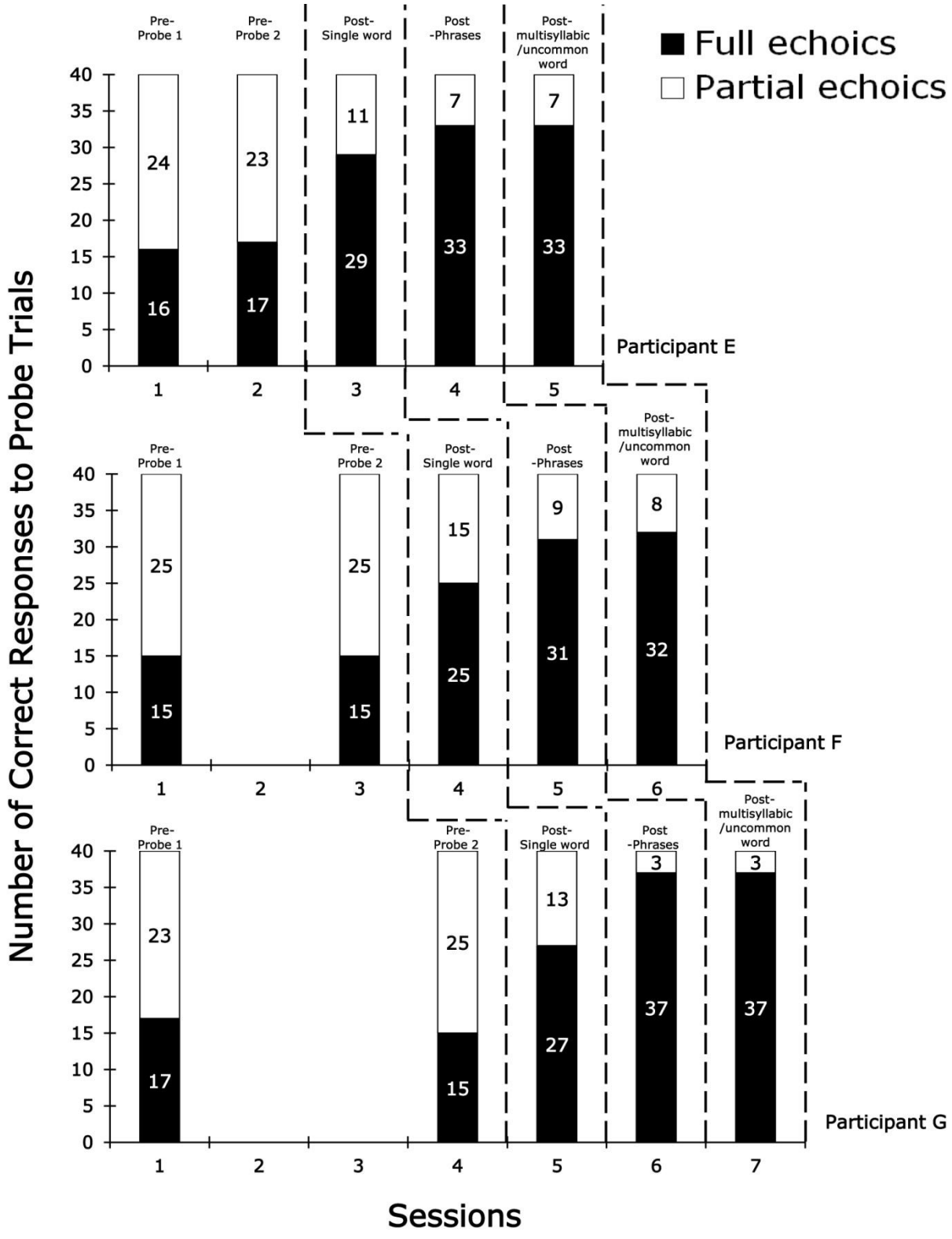

Figure 15. Number of full, partial, and incorrect echoic responses to 40 Korean novel sound words for Participants E, F, and G.

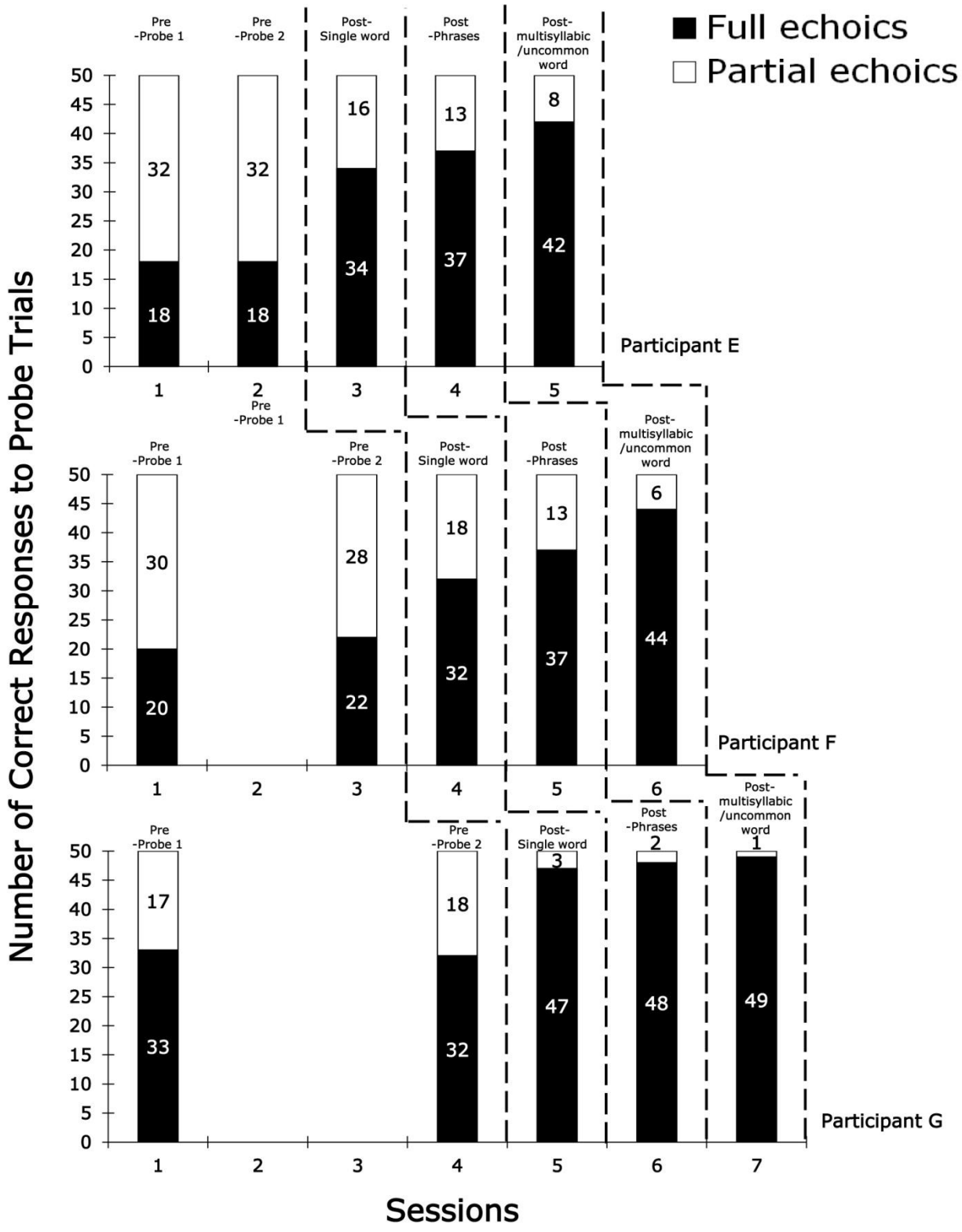

Figure 16. Number of full, partial, and incorrect echoic responses to 50 English words for Participants E, F, and G.

Echoic Responses to Phrases. Figure 17 shows participant's full echoic responses to three and four word phrases. In Pre-probe 1 and 2, Participant E emitted 16 and 13 full echoic responses to 20 probe trials. After mastering the phases of the auditory MTS instruction, she emitted 18 full echoic responses. In Pre-probe 1 and 2, Participant F emitted 12 and 11 full echoic responses, respectively. His full echoic responses increased to 20. Participant G showed 19 full echoic responses in both pre-probe sessions. Following completion of the auditory MTS instruction, he emitted 20 full echoic responses to 20 probe trials.

Conditioned Reinforcement for Adult Voices. Figure 18 shows the numbers of intervals in which the participant emitted correct listening to the pre-recorded adult voices. In Pre-probe 1 and 2, Participant E listened to the pre-recorded adult voice for 5 and 7 intervals, respectively. After mastery of the auditory MTS instruction, the numbers of intervals in which she listened to the pre-recorded adult voices increased to 50. Participant F appropriately listened to the pre-recorded adult voice for 13 and 5 intervals in Pre-probe 1 and 2. The intervals of his listening to the pre-recorded adult voice also increased to 30 following completion of the auditory MTS instruction. Participant G listened to the pre-recorded adult voices for 20 and 15 intervals in the pre-probe sessions. The intervals of listening to the pre-recorded adult voices significantly increased to 60 after he mastered all the phases of the auditory MTS instruction.

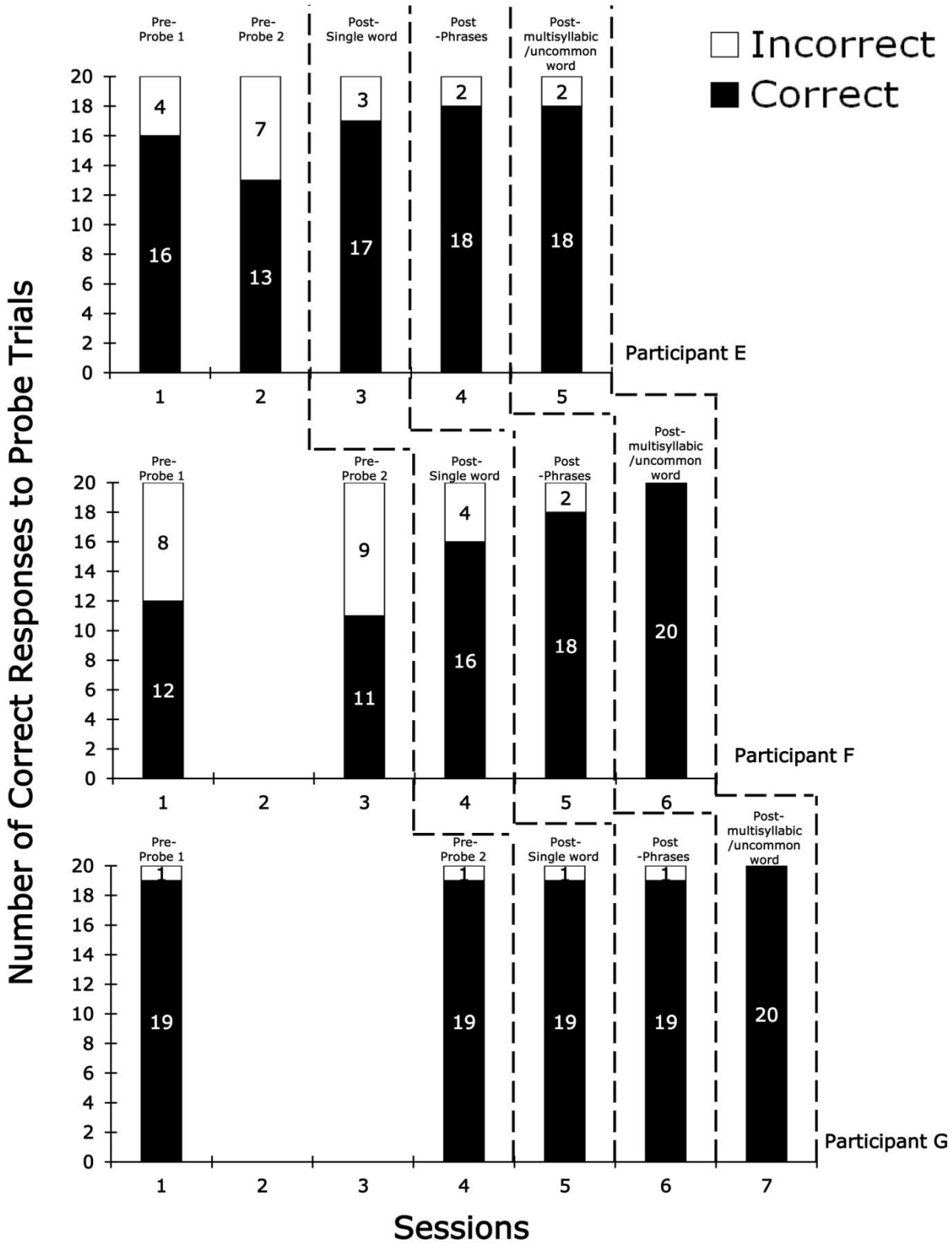

Figure 17. Number of full echoic responses to 20 three or four word phrases for Participants E, F, and G.

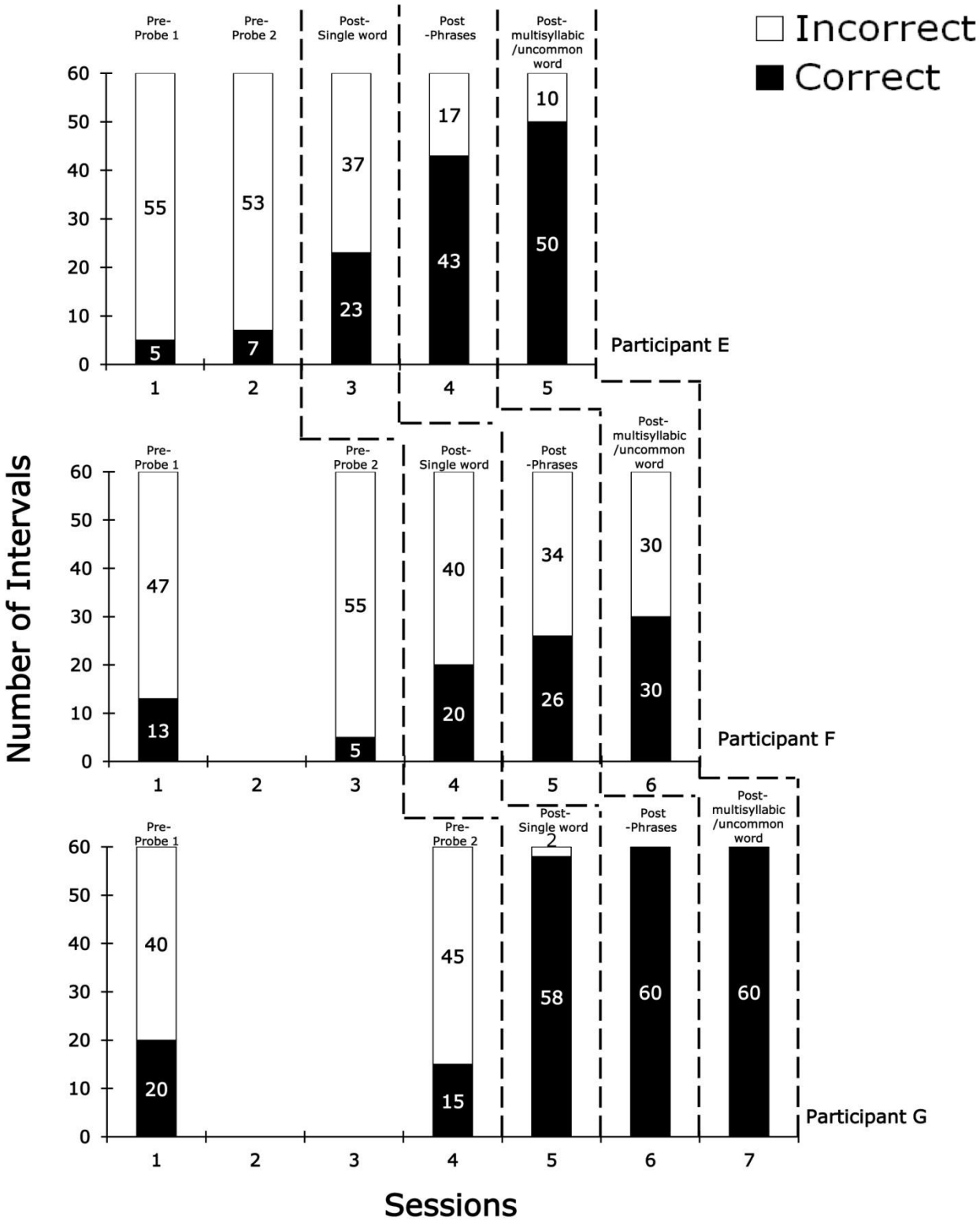

Figure 18. Number of intervals emitting correct responses to pre-recorded voices during the pre-probe and post-intervention probes for Participants E, F, and G.

Correct Responses during the Intervention. During the advanced auditory MTS sessions (Figure 19 and 20), Participant E required 28 sessions to complete all 6 auditory MTS phases for single words, 6 sessions to complete all 3 auditory MTS phases for phases, and 4 sessions to complete all 4 auditory MTS phases for multisyllabic and uncommon words. Participant F mastered all 6 auditory MTS phases for single words in a total of 19 sessions, all 3 auditory MTS phases for phrases in 7 sessions, and all 4 auditory MTS phases for multisyllabic and uncommon words in 4 sessions. Participant G completed all 6 auditory MTS phases for single words in a total of 19 sessions, all 3 auditory MTS phases for phrases in 5 sessions, and all 4 auditory MTS phases for multisyllabic and uncommon word in 4 sessions.

The results of Experiment 2 showed that the advanced auditory MTS instruction was effective in the acquisition of advanced listener literacy for all participants. The advanced auditory MTS instruction also resulted in the emergence of full Naming for Participant E. Participant G achieved a listener half of Naming following the mastery of the auditory MTS instruction. Participant F and G's untaught speaker responses (i.e., speaker half of Naming) also increased significantly. Participant F's correct tact and intraverbal responses increased from 0% to 75% and from 0% to 85%, respectively. Participant G's correct tact and intraverbal responses also increased from 0% to 75% and from 0% to 50%, respectively.

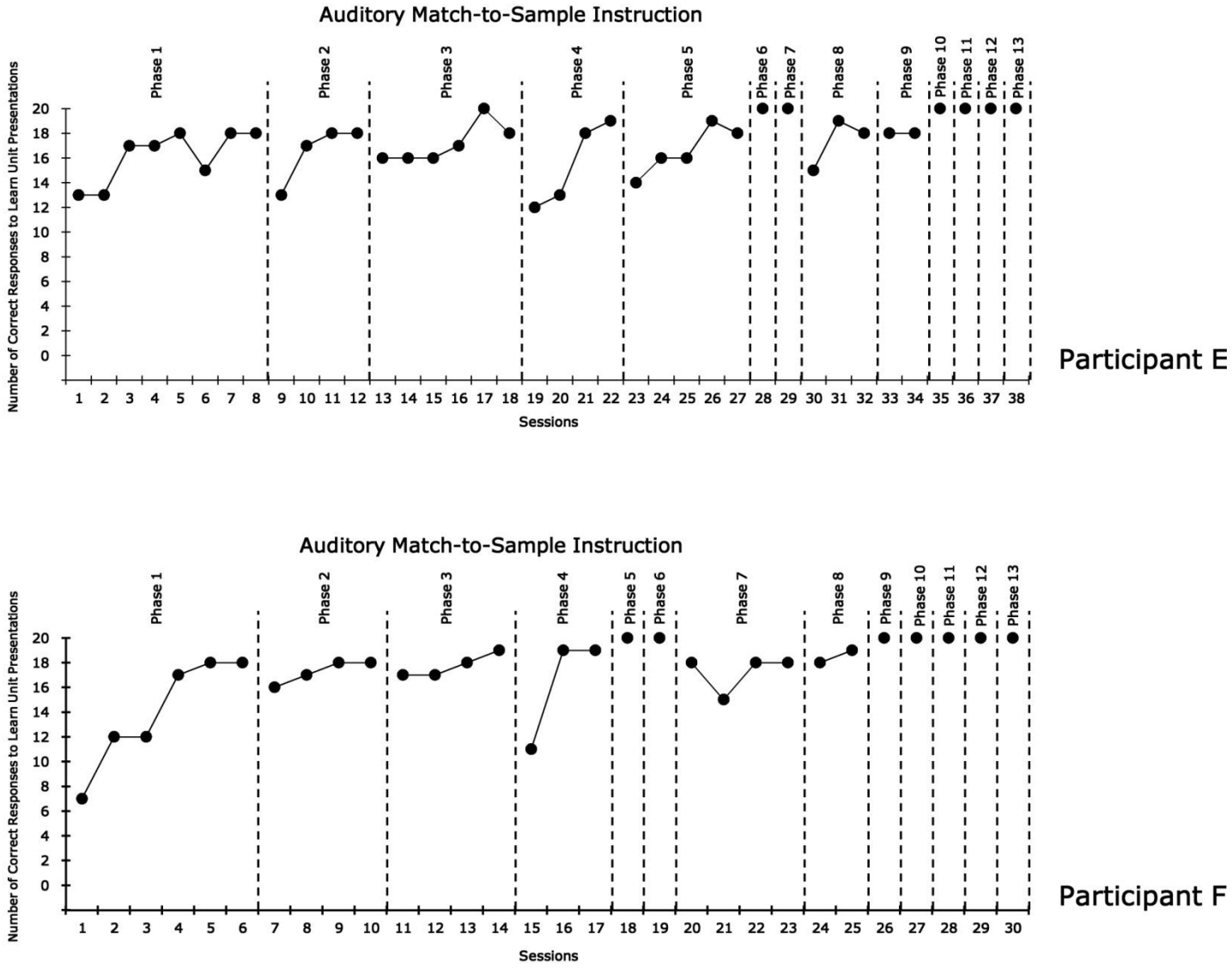

Figure 19. Number of correct responses emitted by Participants E and F during the advanced auditory MTS instruction.

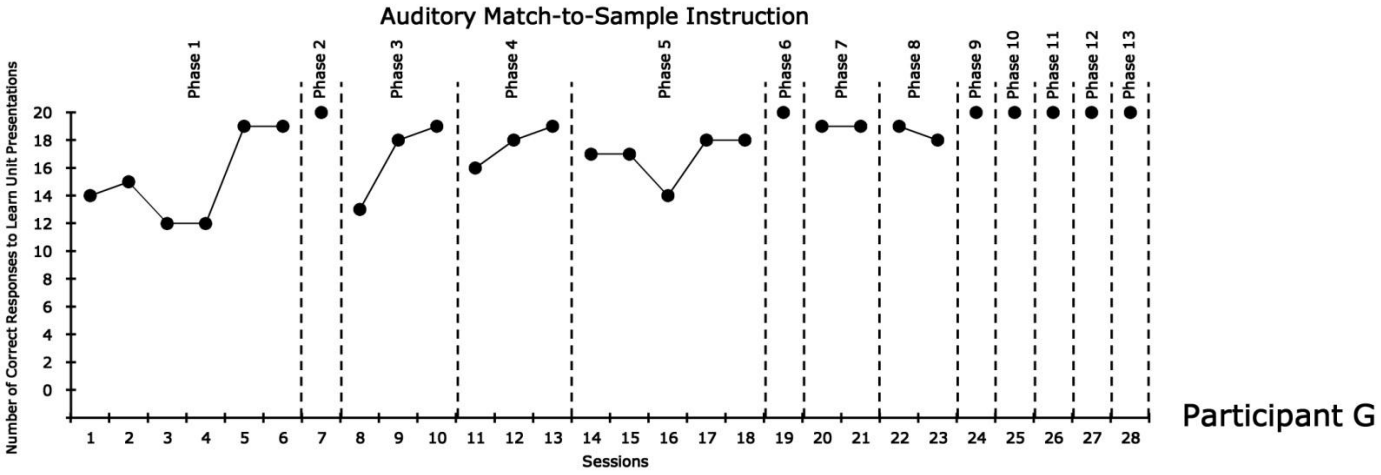

Figure 20. Number of correct responses emitted by Participant G during the advanced auditory MTS instruction.

However, Participants F and G did not achieve the criterion (i.e., 80% accuracy for both tact and intraverbal) to identify the emergence of speaker components of Naming. The results also demonstrated that the advanced auditory MTS instruction resulted in the improvement of the full echoic responses to 50 English single words, 20 phrases and 40 Korean novel sound words. For Participants E and G, the probe sessions for conditioned reinforcement for adult voices demonstrated that the adult voices changed to fully conditioned reinforcement as a function of the advanced auditory MTS instruction. Participant G also listened to adult voices for more intervals after the mastery of the advanced auditory MTS instruction.

Discussion

In Experiment 2, I tested the effects of mastery of the advanced auditory MTS instruction on the emergence of speaker-as-own-listener cusps and advanced listener literacy along with the improvement of full echoic responses to phrases and novel sound words. Findings from Experiment 2 showed that both speaker and listener components of Naming were significantly improved through advanced auditory MTS instruction. Participant E achieved both speaker and listener components of full Naming after mastery of the advanced auditory MTS instruction. Participant G achieved listener half of Naming through advanced auditory MTS instruction. Even though Participants F and G did not achieve the criterion (i.e., 80% accuracy) for emergence of speaker half of Naming, their untaught speaker responses in Naming probes significantly increased close to the criterion levels. These results of Experiment 2 were consistent with Experiment 1.

In Experiment 2, the experimenter investigated the effects of mastery of the advanced auditory MTS instruction on the speaker-as-own-listener cusps of: (1) self-talk, (2) say-do correspondence. The results demonstrated that Participants E and F emitted more self-talk and say-do correspondences as advanced auditory MTS progressed. All three participants emitted more tacts and mands during the free play probe sessions after the completion of the advanced auditory MTS instruction.

Experiment 2 also systematically replicated the experimental procedures of Experiment 1 to test again the effects of mastery of the advanced auditory MTS instruction on the emergence of advanced listener literacy and the improvements of full echoic responses to phrases and novel sound words. The results of Experiment 2

were consistent with Experiment 1. After mastery of the auditory MTS instruction, all three participants' listener literacy was improved. All the participants emitted more correct responses to the vocal directions presented along with visual distracters in distracters post-auditory MTS probes. The completion of the advanced auditory MTS instruction also resulted in the significant improvements of full echoic responses to novel sounds across all participants.

According to Speckman-Collins, Lee Park, and Greer (2007) and Longano (2008), the conditioned reinforcement of voices may be potential source of the listener components of Naming. Keohane, Pereira-Delgado, and Greer (2009) and Greer and Ross (2008) described that fluent listener literacy and listener responses can be improved when the adult voices function as the conditioned reinforcers. Speckman-Collins, Lee Park, and Greer (2007) argued that auditory MTS instruction possibly provides the history of reinforcement that functioned to condition the adult voices as reinforcers for listening to speech. In Experiment 2, probes were conducted to identify the degree of conditioned reinforcement for adult voices prior to and after the completion of each set of the advanced auditory MTS instruction (Greer & Ross, 2008; Keohane, Luke, & Greer, 2008; Greer, Pistoljevic, Cahill, & Du, 2011; Keohane, Pereira-Delgado, & Greer, 2009). The results of the voice conditioning probes showed all the participants listened to the prerecorded voices for more whole intervals as advanced auditory MTS progressed. Participants E and G listened the prerecorded stories for over 80% of 60 five second intervals. The numbers of intervals of Participant F's listening also significantly increased from 5 to 30. Findings from Experiment 2 showed a functional relation between the mastery of the

advanced auditory MTS instruction and emergence of the adult voices as conditioned reinforcers. These results of the voice conditioning probes support the arguments of Speckman-Collins, Lee Park, and Greer (2007) and Longano (2008).

Therefore, Experiment 2 showed that advanced auditory MTS instruction possibly provided the history of reinforcement that functioned to condition the adult voices as reinforcers for listening to speech. Conditioned reinforcement for adult voices would result in the improvement and emergence of advanced listener literacy and speaker-as-own-listener-cusps (i.e., Naming, self-talk, and say-do correspondence). The function of conditioned reinforcement for adult voices could also provide the source of the improvement of full echoic responses to phrases and novel sound words.

A limitation of Experiment 2 was that the functions of materials used for Participant G's free play probes were different from Participant E and F's. The anthropomorphic toys were fully conditioned reinforcers with which Participants E and F could play with during the solitary free play probe sessions. During pre- and post-intervention free play probe sessions, Participants E and F emitted more appropriate play activities rather than stereotypy. For Participant G, however, the anthropomorphic toys were not fully conditioned reinforcers and he emitted vocal or physical stereotypy rather than appropriate play activities during the free play probe sessions. This limitation possibly affected the emission of Participant G's self-talk and say-do correspondences. The experimenter did not observe considerable changes in self-talk and say-do correspondences prior to and after the implementation of the advanced auditory MTS instruction for Participant G.

Chapter IV

GENERAL DISCUSSION

Summary of Results and Major Findings

In both Experiments 1 and 2, I tested the effects of mastery of the advanced auditory match-to-sample (MTS) instruction on the emergence of advanced listener literacy and Naming, and the emission of full echoic responses. The results of Experiment 1 suggested that the advanced auditory MTS instruction might act to induce or increase the speaker and listener components of Naming. 2 out of 4 participants from Experiment 1 acquired full Naming after the mastery of the advanced auditory MTS instruction. The other two participants did not achieve full Naming. 1 out of 3 participants from Experiment 2 acquired full Naming after the mastery of the advanced auditory MTS instruction. In Experiment 2, I tested the effects of mastery of the auditory MTS instruction on the possible emergence of all speaker-as-own-listener cusps (i.e., Naming, self-talk, and say-do correspondence). Moreover, I also tested for preference for listening to recordings of voices as a measure of the reinforcement value of voices before and after the intervention (Greer, Pistoljevic, Cahill, & Du, 2011; Speckman-Collins, Lee Park, & Greer, 2007; Longano, 2008). Tests for changes in the reinforcement value of voices were conducted to identify if changes in reinforcement for voices assisted an auditory MTS ability and speaker-as-own-listener cusps. Prior research suggested that changes in conditioned reinforcement for voices might be the source for the effect.

Advanced Listener Literacy

In both experiments, all participants' correct responses to the advanced listener literacy probes increased after the mastery of the advanced auditory MTS instruction. Participants B, C, D, and G showed the greatest increases in the advanced listener literacy probe trials. Participants A, E, and F's correct response also increased but less so. The advanced listener literacy probes showed that the participants were under the vocal antecedent stimulus control rather than visual distracters after the auditory MTS instruction. That is, the participants achieved the ability to respond more fluently and discriminatively to the auditory properties of speech (Greer, Chavez-Brown, Nirgudkar, Stolfi, & Rivera-Valdes, 2005). This improvement is consistent with the investigations of Lee Park (2005), Chavez-Brown (2005), and Speckman-Collins, Lee Park, and Greer (2007) in which a basic auditory MTS instruction induced listener literacy.

Speaker-as-Own-Listener Cusps

In Experiments 1 and 2, both speaker and listener components of Naming improved significantly as a function of the auditory MTS instruction. Participants A, C, and E achieved both speaker and listener components Naming after the mastery of the auditory MTS instruction. Participants B, D, and G achieved listener half of Naming, and their untaught speaker responses in Naming probes responses were close to the criterion levels (i.e., 80% accuracy)..

The post-auditory MTS instruction data also showed that Participants E and F emitted more conversational units, sequelics, and self-talk during the solitary free

play probe sessions, but this was not the case with Participant G. All three participants emitted more tacts and mands after the intervention.

Full Echoics

The results for all participants showed that the auditory MTS with words resulted in the increase in full echoic responses and decreases in partial echoic responses for both English and Korean words. The improvement of full echoic responses to Korean novel sound words was more significant than the improvement of full echoic responses to English words.

Conditioned Reinforcement for Voices

The current study showed the auditory MTS instruction can potentially provide the essential source for the emergence of advanced listener literacy, speaker-as-own-listener cusps, and full echoics. The first verbal behavior study on an auditory word MTS instruction (Chavez-Brown, 2005) reported that some echoics emerged for non-speaking participants, but the biggest effect was on clarifying the speech of children who lacked full echoics, but who had speech. The more stringent procedure used in the present studies led to marked changes in components associated with the developmental intercept of the listener and speaker within the skin (Skinner, 1957). The fact that the procedure assisted in the joining of the listener and speaker was surprising. This led to the question of how the components of the auditory MTS instruction possibly made the emergence of advanced listener literacy and speaker-as-own-listener cusps.

The sequence of studies by Lee Park (2005), Speckman-Collins, Lee Park, and Greer (2007) and Longano (2008) suggested that a reinforcement conditioning effect

may have occurred in the auditory MTS resulting in the emergence of the listener and/or speaker components of Naming. Lee Park (2005), Speckman-Collins, Lee Park, Greer (2007), and Keohane, Luke, and Greer (2008) also argued that auditory MTS instruction possibly established adult voices as conditioned reinforcers by incidentally providing stimulus-stimulus pairing that, in addition to improving listener literacy, also in advertently functioned to condition voices as reinforcers for listening to speech.

Longano (2008) in her unpublished dissertation found that a stimulus-stimulus pairing procedure acted: (a) to induce Naming when MEI did not for some children and (b) for children who had no other interventions the stimulus-stimulus pairing instruction alone acted to induce Naming.

In my second experiment, prior to and after the completion of each set of the auditory MTS stages, probes were conducted on changes in conditioned reinforcement for adult voices (Greer, Pistoljevic, Cahill, & Du, 2011; Greer & Ross, 2008; Keohane, Luke, & Greer, 2008; Keohane, Pereira-Delgado, & Greer, 2009). The result of Experiment 2 showed that the auditory MTS instruction potentially resulted in the conditioning effects for voices. All participants from Experiment 2 listened to the prerecorded speech samples for more whole intervals progressively at the completion of each set of the auditory MTS instruction. Participants E and F listened to the pre-recorded adult voices for over 80% of 60 five second intervals after the completion of all of the stages of the advanced auditory MTS instruction. Therefore, the results suggested that the advanced auditory MTS instruction possibly functioned to condition the adult voices as conditioned reinforcers. The auditory MTS

instruction possibly provided the history of reinforcement that functioned to condition the adult voices as reinforcers for listening to speech. As the advanced auditory MTS instruction progressed, the participants followed the vocal antecedents rather than the visual distracters. Increases in conditioned reinforcement value for listening to speech sounds appear to be a likely contributor to the emergence of the three speaker-as-own-listener cusps and capabilities. That is, the results were consistent with the argument from Lee Park (2005), and Speckman-Collins, Lee Park, and Greer (2007), and Longano (2008). As the adult voices were conditioned as reinforcers, the participants' full echoic responses increased and Naming was possibly emerged. Additionally, the results of the other speaker-as-own-listener cusps (self-talk s and say-do correspondence) can emerge potentially by the same source for the emergence of Naming.

Therefore, the current study showed the auditory MTS instruction can potentially provide the essential source for the emergence of advanced listener literacy, speaker-as-own-listener cusps, and full echoics. However, whether or not the auditory MTS instruction can or cannot induce conditioned reinforcement for voices may depend on the existing verbal developmental cusps that the children have before they experience the auditory MTS instruction. Alternately, the auditory MTS instruction may do it for children who lack the cusps that the children in the present studies brought to the table. Additional research needs to determine what types of children acquire conditioned reinforcement. When a child has a certain degree of listener literacy control for the auditory MTS to work, the auditory MTS instruction could be effective to induce the advanced listener literacy, listener and/or speaker

components of Naming, and other speaker-as-own-listener cusps (i.e., say-do correspondence and self-talk). If a child does not have any listener literacy voice control or conditioned reinforcement for voices in his/her repertoire. The voice conditioning instruction should be implemented before the auditory MTS instruction (Keohane, Luke, & Greer, 2008; Keohane, Pereira-Delgado, & Greer, 2009; Eby, Pistoljevic, and Du, in press).

Limitation

There were some limitations in Experiment 2. All participants from Experiment 2 emitted 100% correct auditory MTS response in the last training multisyllabic and uncommon word MTS set. That is, the participants' auditory MTS responses had already generalized to the novel words and sounds after the completion of the first two sets (i.e., matching words, and matching phrases) of the auditory MTS instruction. During the last training multisyllabic and uncommon word phases, learning new operants may not occur. It is possible that a training effect would increase correct responses in the last probe sessions. Although all probe sessions were unconsequated, the participants were exposed to the same set of words and phrases for echoics multiple times throughout the study, it is possible that the repeated exposure led to the improvement in their echoic responses through confounding training effects with repeated testing.

Another limitation of the study involved the functions of materials used for Participant G's solitary free play probes. Improvements in contextually appropriate self-talk and say-do correspondences did not occur for Participant G. Since

Participant G did not complete a systematic stimulus-stimulus pairing instruction to reduce stereotypy prior to the current study, he emitted vocal or gestural stereotypy with the anthropomorphic toys rather than appropriate functional toy play (Greer & Ross, 2008; Nuzzolo-Gomez, Leonard, Ortiz, Rivera, & Greer, 2002; Tsai, 2003; Tsai & Greer, 2006). Due to lack of stimulus-stimulus pairing instructional history for Participant G, he possibly affected Participant G's low number of self-talk and say-do correspondences in that stereotypy competed with the latter response (Lodhi, & Greer, 1989). Prior to the current study, however, Participant E and F already completed a systematic stimulus-stimulus pairing instruction to condition the anthropomorphic toys as reinforcement to reduce the emission of stereotypy with the anthropomorphic toys**.** Participants E and F emitted appropriate play with the anthropomorphic toys rather than stereotypy since the anthropomorphic toys were already conditioned reinforcers and prior studies have shown that this history reduces stereotypy.

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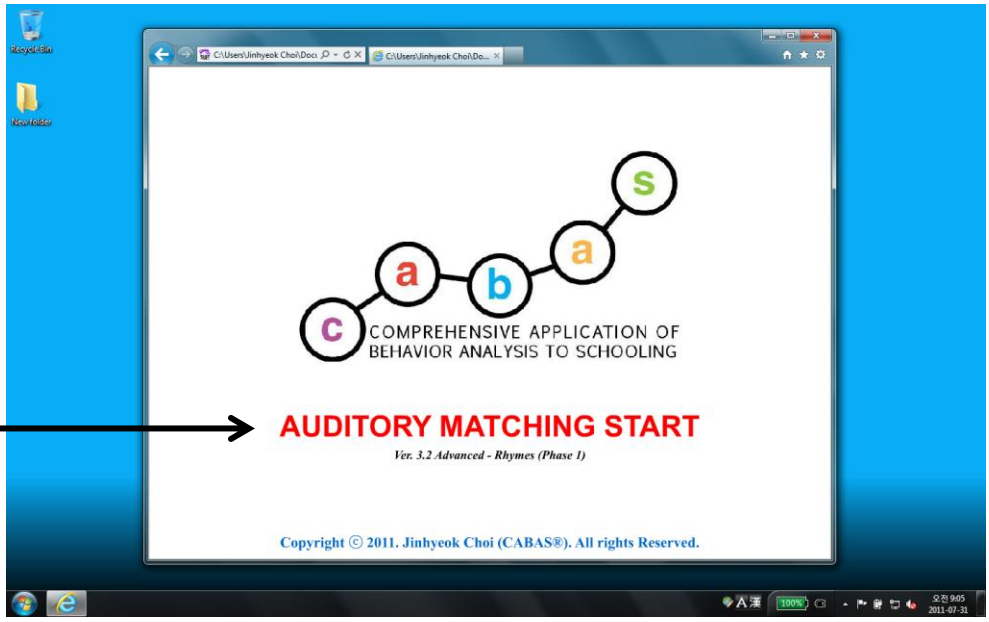
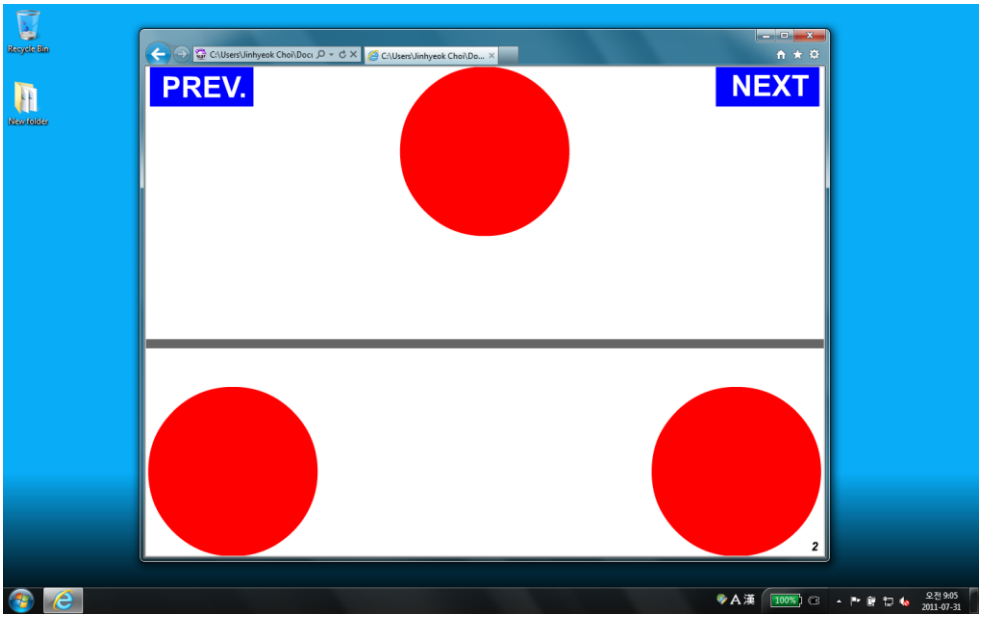
Appendix A

Picture of the auditory match-to-sample Flash® computer program



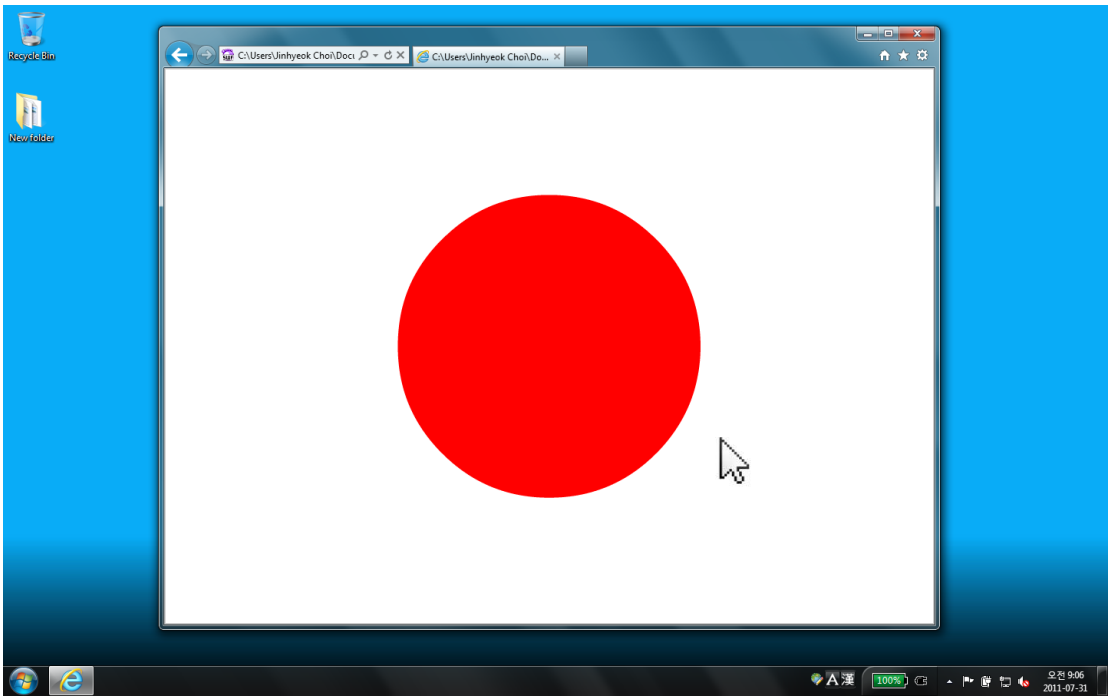
Title page. The experimenter clicked the "auditory matching start" button to start the auditory match-to-sample instruction.



Instructional page. The top button produced the sample word or phrase, and the two buttons located below produced the exemplar and non-exemplar word or phrase.

Appendix B

Picture of the voice conditioning Flash® program used during the probe sessions to identify the degree of conditioned reinforcement for adult voices.



When the participant followed and kept a pointing arrow on the red button, pre-recorded stories were played.