

The Role of Joint Control in Teaching Complex Behavior to
Children with Autism

Vincent J Carbone, Ed.D, BCBA-D
NYS Licensed Behavior Analyst

Carbone Clinic
New York – Boston – Dubai
www.CarboneClinic.com

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**BRIEF HISTORY OF APPLIED BEHAVIOR ANALYSIS (ABA)
AND VERBAL BEHAVIOR**

- 1938 – Skinner wrote *Behavior of Organisms*
(reinforcement, extinction, motivation, punishment, stimulus control)
- 1950 – Keller and Schoenfeld wrote the textbook *Principles of Psychology*
- 1953 – Skinner wrote *Science and Human Behavior*
- 1957 – Skinner wrote *Verbal Behavior*
- 1958 – *Journal of the Experimental Analysis of Behavior* started
- 1959 – Chomsky wrote a critique of *Verbal Behavior*
- 1959 – Michael and Ayllon wrote “The Nurse as a Behavioral Engineer”
- 1960’s – Lovaas begins research at UCLA with children with autism using operant conditioning methods (discrete trial training)

- 1968 – Baer, Wolf, and Risley publish “Some Current Dimensions of Applied Behavior Analysis” in the *Journal of Applied Behavior Analysis (JABA)*
- 1970’s – Michael begins teaching verbal behavior at Western Michigan University
 - Sundberg begins researching verbal behavior with Michael and Partington
- 1982 – Sundberg started the *Analysis of Verbal Behavior* journal
- 1984 – Shook started the Florida Certification of Behavior Analysts
- 1998 – Shook started the National Board Certification of Behavior Analysts
 - Sundberg and Partington published *Teaching Language to Children with Autism or Other Developmental Disabilities* and *The Assessment of Basic Language and Learning Skills (ABLLS)*

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Language Acquisition

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Non-Behavioral Accounts of Language Development

- Traditional theorists (such as Chomsky, Piaget, Pinker, Brown, Brunner, etc.) view language development as an innate, biological process, not due to environmental factors, but instead controlled by internal cognitive mechanisms which accept, classify, code, encode, and store information.

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- According to these theories, ***words and sentences***, or the ***form of language***, are the important units of analysis.
- Emphasis is placed upon the topography or form of language such as:
 - Syntax (ordering of words)
 - Grammar (conventions or rules)
 - Morphemes (smallest unit of meaning e.g. -ed, -ing, -s)
 - Phonemes (sounds)
 - Semantics (word meaning)
 - Pragmatics (social use of language)
 - Mean Length of Utterance (MLU)
 - Lexicon (collection of words)
- Words are typically classified into nouns, verbs, adjectives, etc.

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- This traditional account classifies language into two categories:
 - Expressive language
 - Receptive language
- The traditional account of language dominates the field of language assessment as well as the treatment approach for children who are language disordered or delayed.

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SUMMARY OF THE NON BEHAVIORAL ANALYSIS OF LANGUAGE

1. Verbal behavior is explained in terms of underlying mental causes and activities
2. Persons use words in order to express themselves, convey ideas or to expressing meaning.
3. The word is regarded as a symbol that is used to represent the ideas it is designed to convey.
4. The meaning of the word is defined by its referent.

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5. The meanings of words are stored in the lexicon which is accessed prior to speech.
6. Language is regarded as the output of various “cognitive mechanisms” that manipulate the symbols and generate the language according to rules.
7. There are various aspects of speech (nouns, verbs, adjectives, adverbs, prepositions, etc.) and various rules of grammar and syntax regarding the usage and manipulation of these parts of speech.
8. These rules are thought to be mental and innate. This includes Chomsky’s idea of innately acquired universal transformational grammar that resides in the Language Acquisition Device.

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9. What a person says emerges when various rules are applied to the underlying grammatical structure.
10. All people are born with these universal underlying structures that account for the development of language.
11. The language one ultimately speaks results from exposure to the sounds of a language early on in life which then trigger the underlying structures to enable the individual to speak consistent with the rules of grammar.

Jay Moore (2007, p. 166)

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Behavioral Account of Language



- In 1957, Skinner wrote the book *Verbal Behavior* where he offered a behavioral interpretation of language.
- In contrast to traditional theorists, B. F. Skinner argued that language is not some innate, cognitive or developmental process but rather language is behavior, verbal behavior, and is best explained by same environmental variables that explain all other behavior.

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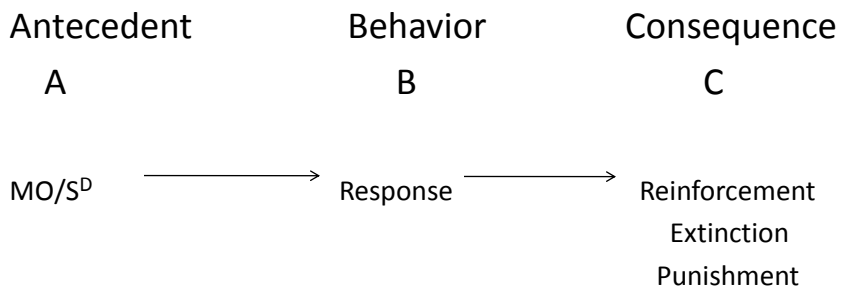
Behavior Analysis

- Antecedent: before behavior
 - Stimulus control
 - Motivation (MO)
- Behavior
 - Response form (all kinds of behavior)
- Consequence: immediately following behavior
 - Reinforcement: increases behavior
 - Extinction: weakens behavior
 - Punishment: decreases behavior

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Behavior Analysis

- Behavior is analyzed through the three-term contingency.

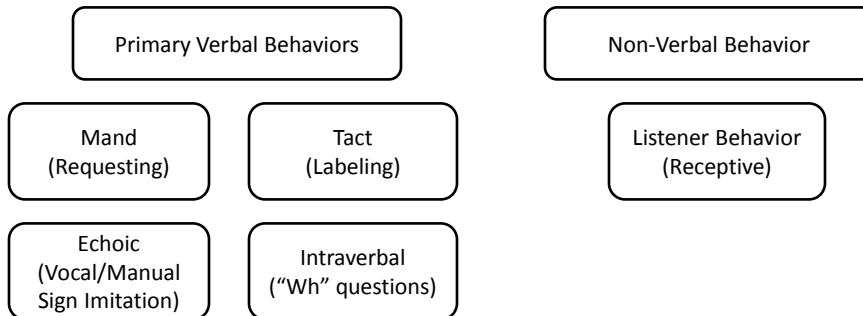


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- Therefore as behavior, verbal behavior is best analyzed and explained by considering the environmental stimuli that precede it, or its antecedents, and stimuli that follow it, or its consequences.
- In a behavioral analysis of language, a word is not defined by its form rather a word is defined by its **function** or controlling variables.
- Language is classified into functional categories which are referred to as verbal operants.

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Behavioral Classification of Language



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NONVERBAL BEHAVIOR

Want Water -----walk to the refrigerator-----Get Water

VERBAL BEHAVIOR

Want Water-----say water-----Person Delivers Water
 sign Water
 point to water
 whine
 exchange a picture
 kick someone
 scream
 write water

Saying Water is Behavior- Movement of Muscles of the Vocal Apparatus that Produces Acoustic Stimulus.

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Skinner's (Nature's) Verbal Behavior Categories

Verbal Responses

- Mand (Requesting) : Asking for reinforcers that you want. Saying "candy" because you want candy. (Birth to 12 months-non-vocal mands in the form of crying; pointing, 12 months first word, then 2 words (noun & verb) at 24 months; mand for information at @ 36 months)
- Tact (Labeling): Naming or identifying objects, actions, events, etc. Saying "candy" because you see candy. (12 months- 1 word; 24 months- 2 word (noun & verb) at 24 months; 36 months- at least 500 words)
- Echoic (Vocal Imitation): Repeating what is heard. Saying "candy" after someone else says "candy". (Birth -6 months universal sounds; 6 months-12 months- sounds heard during daily activities; 12 months- echo some phonemes and phoneme combinations & word approximations)
- Intraverbal ("wh" Questions") : Answering questions or having conversations where your words are controlled by other words. Saying "candy" when someone else says "What do you like to eat?" (30 months- 1 word responses; complexity & length of utterances increase over time; full sentences by 48 months)

Non-Verbal

Listener Responses

- Listener Behavior (Receptive): Motor responses to what someone says.

[Typical Development](#)

[Typical Development W](#)

[Intraverbal Book](#)

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Joint Control

Review of Listener/Speaker Responding

- Skinner's (1957) analysis of verbal behavior offered **an alternative** to the prevailing structural conceptions of language in which words and sentences (i.e. **formal properties of language**) were considered the important units of analysis.
- Whereas structural accounts emphasized the **topography of language** (e.g. syntax, grammar, morphemes, mean length of utterance, etc.), Skinner's behavior analytic account identified the **functional relation** between a response and its controlling variables, or the verbal operant, as the important unit of analysis.
- This behavior analytic account of language suggests important **implications for the treatment** of children with autism and other developmental disabilities (Sundberg & Michael, 2001) and a growing body of clinical work and research has documented the value of including this taxonomy in language training programs (see Sautter & LeBlanc, 2006 for a review).

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- Much of this literature, however, has focused on the application of Skinner's analysis to teaching **speaker behavior**, with less work dedicated to a thorough analysis of the contingencies operating on the **behavior of the listener** (Schlinger, 2008).
- Possibly due to this lack of attention, cognitive explanations that describe the listener as a "passive receptacle" (Schlinger, 2008, p. 149), "recipient" (Lowenkron, 1998, p.339), or "processor" of information (Sidner, 2006) have persisted.
- Although Skinner's (1957) analysis emphasized speaker behavior, he **did not ignore the listener**. Skinner suggested that the control exerted by verbal stimuli was at least partially dependent upon the **listener having an existing verbal repertoire of speaker behavior**.

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- He stated, "...some of the behavior of listening resembles the behavior of speaking, particularly when the listener understands what is said" (Skinner, 1957, p. 10).
- Schlinger (2008) extended Skinner's analysis of listener behavior and refined the difference between listener behavior **as a repertoire of discriminated operants** (i.e., mediation of reinforcement for a speaker) and "listening."
- Schlinger asserted that listening is behaving verbally. He stated, **"...the behavior of listeners and speakers may be inseparable, especially when we say the listener *listens, pays attention to, or understands the speaker*"** (p.148).

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- Schlinger argued that, in fact, listening and speaking may not be functionally different, **“In other words, the listener also behaves verbally when he or she is said to be listening”** (Schlinger, 2008, p.150).
- All of this suggests that listening may be predicated upon a complex verbal repertoire that mediates listener responses.

Joint Control

- Consistent with Schlinger’s (2008) analysis of verbally mediated listener responding, Lowenkron (1991, 1998, 2004, 2006a) has offered joint control as a conceptually systematic explanation of various complex human behavior, including listener behavior.
- Lowenkron (1998) defined joint control as **“ the effect of two (discriminative stimuli) S^Ds acting jointly to exert stimulus control over a common response topography”** (p.328-329).

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- Lowenkron (1998) stated:
“Joint control occurs when the currently rehearsed topography of a verbal operant, as evoked by one stimulus, is simultaneously evoked by another stimulus. This event, the onset of joint stimulus control by two stimuli over a common response topography, then sets the occasion for a response appropriate to this special relation between the stimuli” (p.327).



In other words, one verbal response is simultaneously emitted under two distinct sources of stimulus control.

For example, two possible sources of control are: (1) a verbal stimulus that evokes an **echoic or self echoic** and (2) a nonverbal antecedent S^D that evokes **a tact**.

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- The emission of a single verbal response under two joint sources of stimulus control is a unique event that then exerts control over a third response, typically a selection response which is mediated by the verbal responses.
- Palmer (2006) refers to joint control as a discriminable jump in response strength when two or more concurrent S^D s control a response of a common topography. It is an example of multiple control.

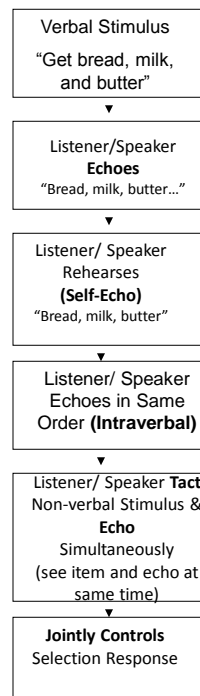
EXAMPLE

- Let's look at an example of joint control in everyday life on the next slide.

Joint Control Example

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In a large grocery store you have been asked to retrieve some items that are located in different places in the store.

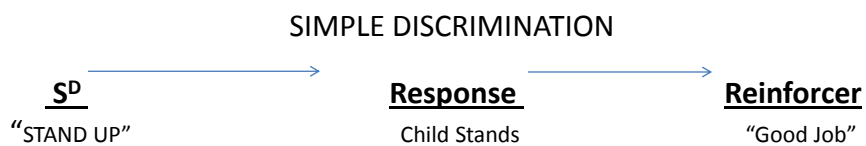


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Joint Control and Word Meaning

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- Simple discriminations are acquired relatively easily by many children with autism, Below is an example of a simple discrimination.

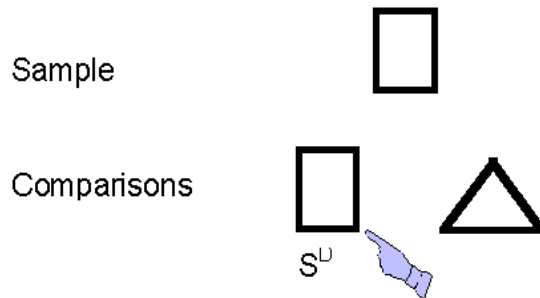


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The Analysis of Joint Control

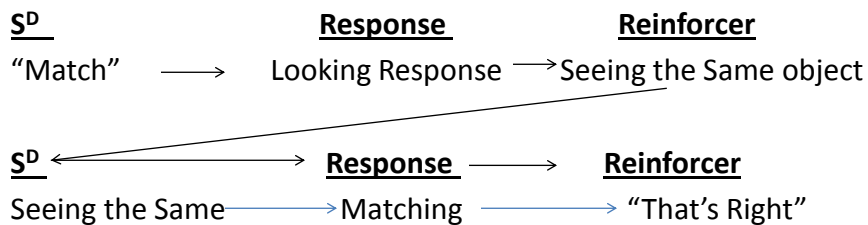
Let's now discuss the details of this process. The following is a description of how the research of Dr. Barry Lowenkron on joint control provides a useful explanation of understanding words and how his work can be applied in clinical settings to teach many skills to children with autism. The figures that follow were copied from Lowenkron (2000) Word Meaning: A Verbal Behavior Account. Presentation at ABAI, Washington, D.C.

OBJECT – OBJECT MATCHING



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Conditional Discrimination



Explanation on Next Slide

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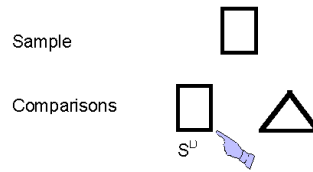
- Object matching or object selection are tasks taught to many children with autism. Figure 1 shows the typical arrangement of a sample to be matched from an array of comparison items or a comparison item to be selected when the teacher says “point to the same”.

- This arrangement is referred to as a conditional discrimination. In this situation, the

selection of correct comparison item (rectangle) is conditioned on the presence of a particular sample item, also a rectangle. It could be said that the presence of the sample item changes the rectangle in the comparison array into a discriminative stimulus for picking it up and placing it on the sample or pointing to it. The sample stimulus momentarily changes the evocative effects of pointing to the comparison rectangle. This arrangement is sometimes referred to as unmediated identity matching.

- This means that an arbitrary relation based upon similarity of shared physical dimensions controls the conditionally discriminated response of matching or pointing. Being arbitrary it could as easily have been the color or some other dimension that becomes the controlling relation.

OBJECT – OBJECT MATCHING



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WORD-OBJECT MATCHING

"SQUARE"



OBJECT-WORD MATCHING

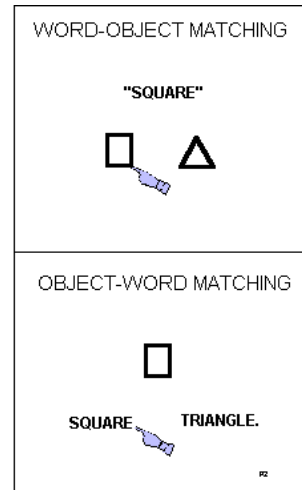


SQUARE TRIANGLE.

GO TO NEXT SLIDE FOR EXPLANATION

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Figure 2 provides two additional examples of unmediated identify matching. Touching the square when someone says square and touching the word square when presented a square as a sample stimulus are both explained according to the information provided above. They are arbitrarily taught responses to physical dimensions of the stimuli.



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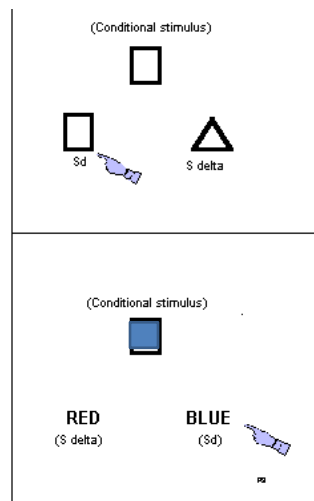


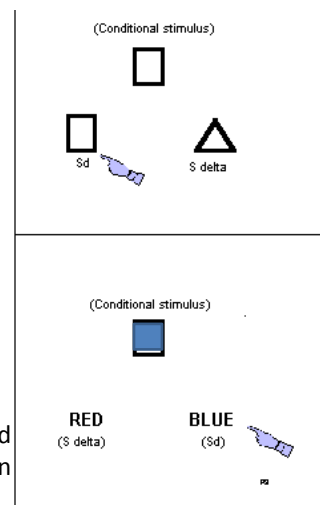
FIGURE 3

GO TO EXPLANATION ON NEXT SLIDE

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- Figure 3 shows the arbitrariness of the unmediated response. Touching blue when shown the square could be taught as easily as teaching the touch of the square when the sample stimulus is a square. The sample and the comparison stimuli are “arbitrarily” inked and not the result of some type of relational responding.

- Therefore teaching unmediated identity matching does not result in the emergence of untrained relations. The person who does not have verbal responses and who learns only unmediated responses may not be able to respond to the relations among the stimuli but respond to only the physical dimensions of the stimuli. The person will only be able to respond to what has been explicitly taught and will not be able to respond to the relations between the stimuli. Look at the examples below in figure 4.



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"SQUARE OVER CIRCLE"
or
"CIRCLE UNDER SQUARE"



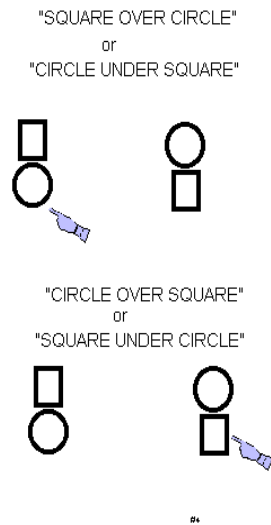
"CIRCLE OVER SQUARE"
or
"SQUARE UNDER CIRCLE"



GO TO EXPLANATION ON NEXT SLIDE

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- A person could be taught to respond to the words “square over circle” and “circle under square” by reinforcing the discrimination with no regard to control by the words over and under. However, since this was taught as an unmediated response to a listener without verbal behavior, he/she would not be able to respond to novel set to relations, e.g. circle over square and square under circle, without explicit control by the words over and under. However, a person with verbal behavior (just do it yourself) could respond to these novel, generalized and unique relations among the stimuli without explicit training because the words over and under control the behavior of a person with those responses as tacts. Therefore, it appears that “understanding word meanings” or responding to unique relations among stimuli without explicit teaching, may be at least partially dependent upon the listener having a verbal behavior (expressive) repertoire. The verbal repertoire provides the listener with a mediating response which is necessary for joint control to occur.



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Stimuli Produced by the Task

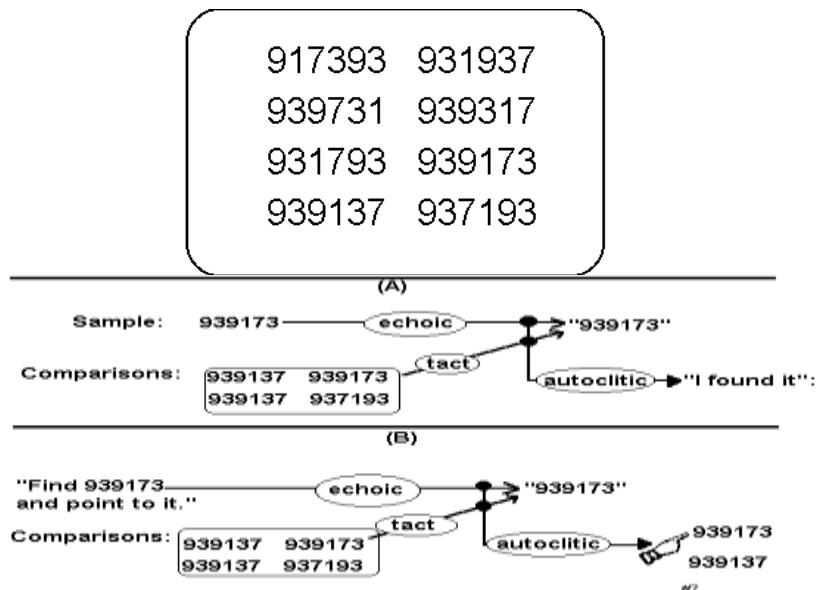
- The distinction between unmediated and mediated stimulus selection accounts present important implications for the arrangement of language training programs for children with autism.
- For example, if a child with autism was to be taught to select two items from a larger field (e.g., “Give me the crayon and the ball” when presented with a field of 10 items), an unmediated stimulus selection account would require that each set of two items be specifically trained and reinforced.
- Conversely, according to the [joint control] account, ... the child’s responses may be brought under the control of the stimuli produced by the task itself and not the specific sample and comparison stimuli used, thus facilitating generalized responding.

—Causin, Albert, Carbone & Sweeney-Kerwin (2013, p. 999)

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- This means that the development of 3 simple operants and their subsequent interaction produce word meaning in a bi-directional way, such as word to object or object to word.
- The 3 operants are the conditional discrimination, the echoic and self-echoic and the tact.
- Once these occur and reinforcement for correct selection occurs then novel verbal stimuli may evoke novel selection responses which will then further strengthen responses under joint control.

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- Note what you did, you repeated the numeral I said as an echoic while searching for the numeral that you could also tact as 939173. When your self-echoic preserved by rehearsal, came into joint control with your tact (really intraverbal) you reported the onset of joint control by making a single response, pointing to the 939173 or saying "that's it" as a descriptive autoclitic response. The onset of joint control is the point at which you recognized the correct response.
- Note how this was a completely unique and generalized response and not one that had been previously taught. You were able to engage in this response because your verbal repertoire mediated the conditional discrimination and allowed you to respond to the relationship between the stimuli (the onset of joint control) and not just respond to the physical dimensions of the stimuli that were brought under discriminative control by previous unmediated conditional discrimination teaching.
- Without verbal behavior you would not have been able to demonstrate your "understanding" of what had been said. It appears that understanding may in fact be the interaction of verbal operants leading to the onset of joint control reported by a third verbal response controlled by the interaction of verbal behaviors and therefore identified as an autoclitic response.

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Let's look at this more closely.

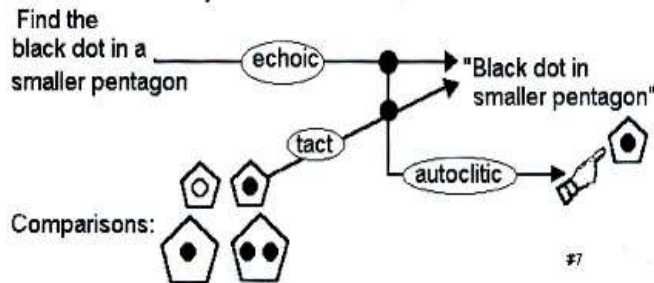
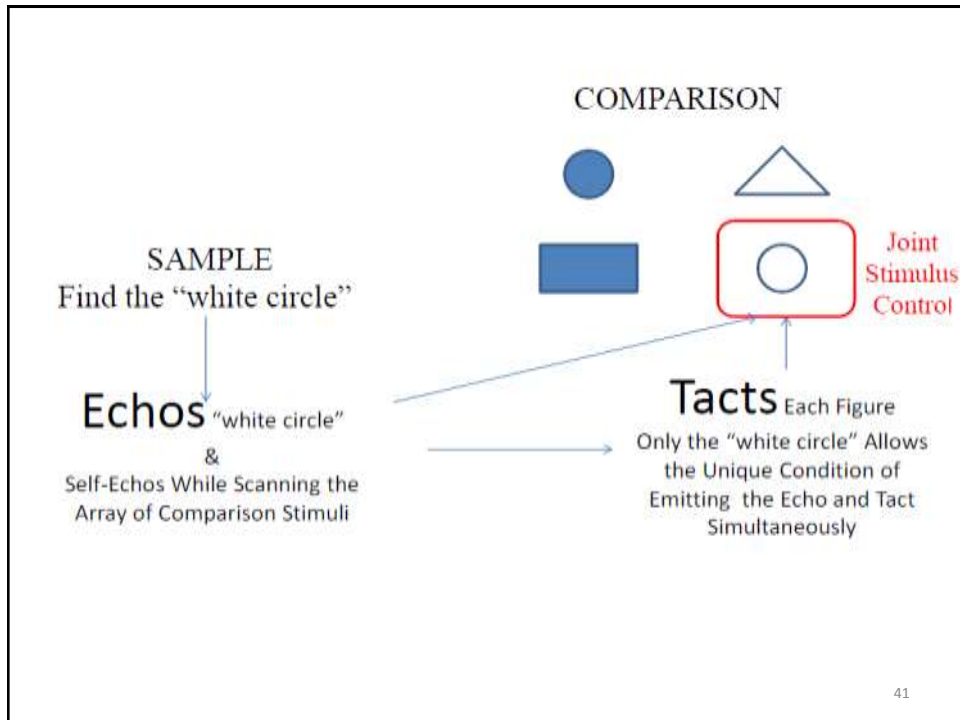


FIGURE 7

Note in Figure 7, above, how you could potentially teach this response also as an unmediated response. But, note how you were able to do this as a generalized response with no prior teaching directly related to this task. Once again, your verbal behavior as a speaker mediated your responding as a listener and you therefore responded to the relations (joint control) among the stimuli.

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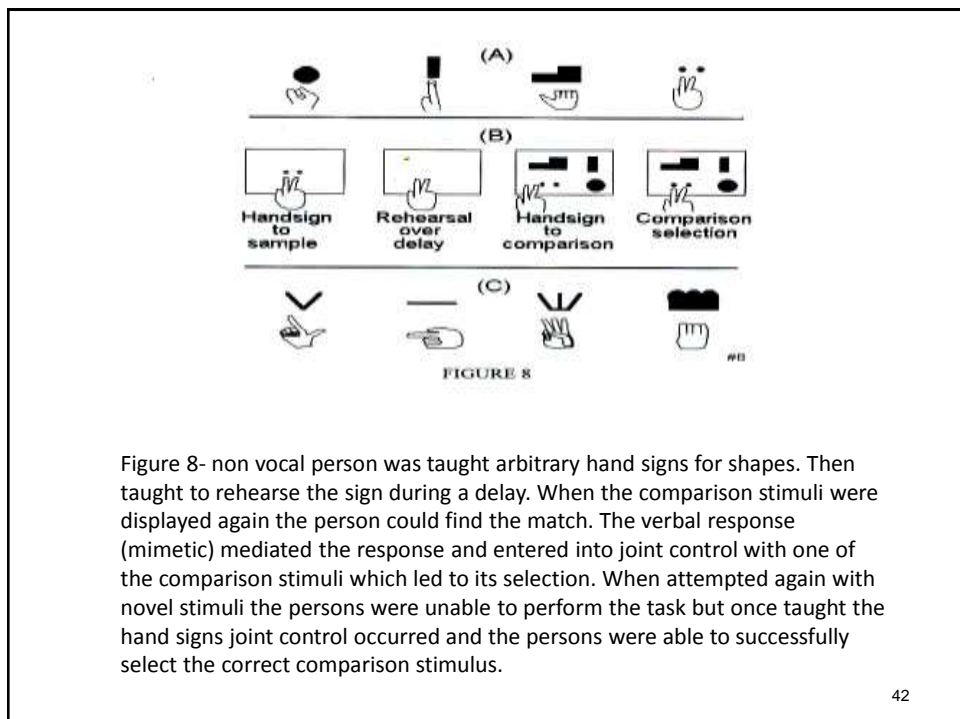


Figure 8- non vocal person was taught arbitrary hand signs for shapes. Then taught to rehearse the sign during a delay. When the comparison stimuli were displayed again the person could find the match. The verbal response (mimetic) mediated the response and entered into joint control with one of the comparison stimuli which led to its selection. When attempted again with novel stimuli the persons were unable to perform the task but once taught the hand signs joint control occurred and the persons were able to successfully select the correct comparison stimulus.

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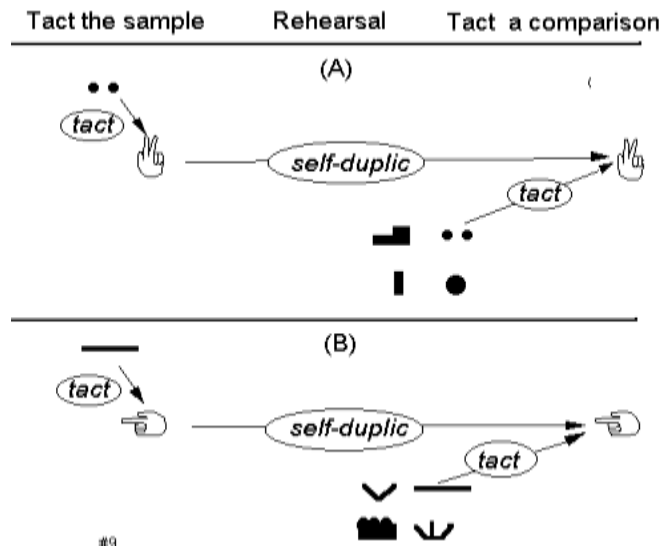
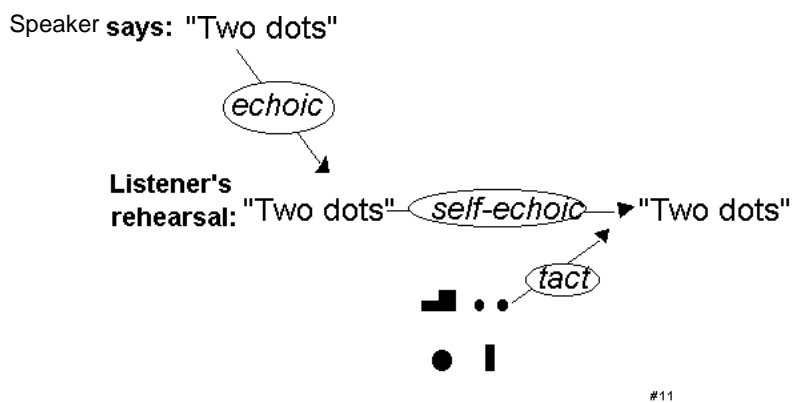


Figure 9 shows the process by which joint control controlled the response

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Vocal Example



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Another Example

Description: Circle in Square

self-echoic

"Circle in Square"

Object described:



tact

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- A referent for a word then is the object event or relation that enters into joint control with that word. The word specifies or informs the listener that the object that comes into joint control with the rehearsal of the word is the referent for it.
- A description is a phrase that tells the listener that the stimulus that enters into joint control with the rehearsed response is what is described by the phrase.
- Onset of joint control is what we report as recognizing the referent or the object, event or relation described. We report our recognition through a descriptive autoclitic response.

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Pigeon Analogue Experiment

- Blough (1959) demonstrated something very similar to this with pigeons in a delayed match to sample experimental preparation.
- During the delay period the pigeons which engaged in differentiated stereotypical behavior (analogous to invented gestural signs) were more likely to emit correct matching responses than those which failed to engage in specific topographical responses during the delay.

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Blough, D. (1959) Delayed matching in the pigeon. *Journal of the Experimental Analysis of Behavior*. 2, 151-160.

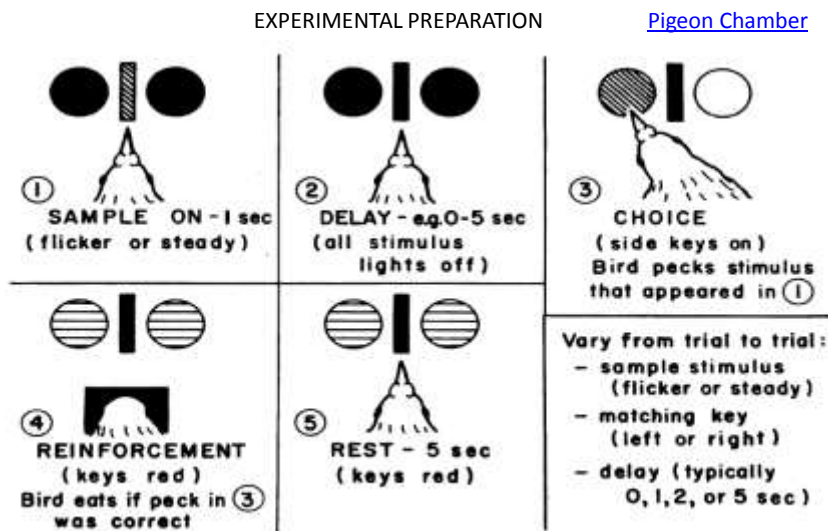


Figure 1. The sequence of events in a single delayed matching trial.

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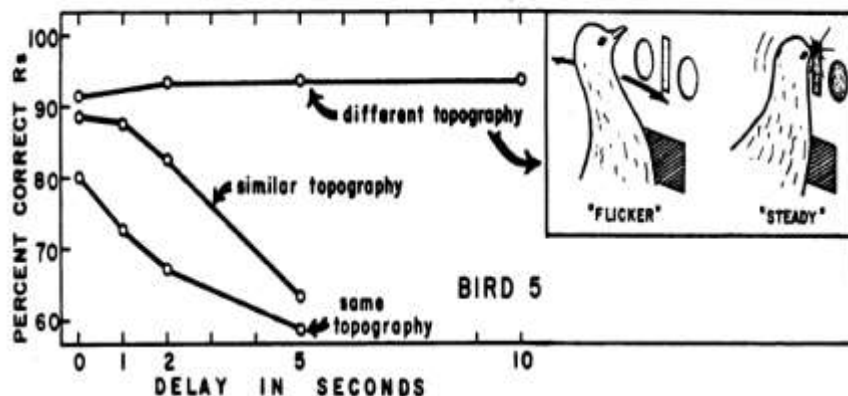


Figure 2. Matching performance of Bird 5 as a function of delay. The different curves correspond to different periods during the experiment. Each point represents mean data from 5 to 10 sessions. (See text.) The inset indicates the bird's delay behavior at the time when the data shown in the upper curve were collected.

Blough, 1959 (p. 152)

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Visual observations during these sessions revealed that during the delay interval the bird was performing stereotyped behavior similar to the "superstitious" behavior described by Skinner (1948). Figure 2 (inset) illustrates this behavior, which consisted of two repetitive chains of quite different topography. When the sample flickered, the bird backed quickly away from the keys and waved its head slowly back and forth throughout the delay interval. Following a steady sample, the bird spent the delay pecking rapidly at the top of the vertical sample bar. Sometimes, Bird 5 did not maintain its head-waving response following a flickering sample through a long delay, but began pecking at the sample bar. When this happened, the bird almost always pecked the steady (incorrect) stimulus when the key lights appeared. Thus, these responses in the delay interval seemed to mediate the discrimination in the sense that they took the place of the sample as stimuli controlling the choice of keys. Other observations which support this notion are described below.

Blough, 1959 (p. 153)

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Following the "superstition" paradigm, it is assumed that at some point during the early sessions of Birds 5 and 1, two behavior chains were related at a better-than-chance level to the two sample stimuli. This having happened, another reinforcement contingency began to operate. For, to the extent that the superstitious chains were correlated with the sample stimuli, they themselves provided discriminative stimuli for the matching responses. Pecks on the flickering key were always reinforced following one of the superstitious chains, and never reinforced following the other chain. The opposite was true of pecks on the steady key. This differential reinforcement strengthened the correct response in the presence of the appropriate chain and ultimately strengthened the chain itself and its association with one of the sample stimuli.

Blough, 1959 (p.157)

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NON RESPONDERS

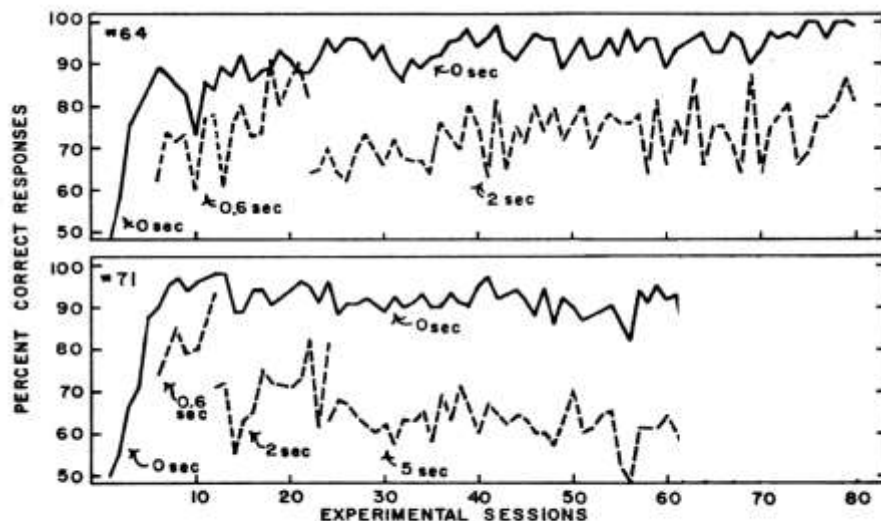


Figure 4. Matching performance of Birds 64 and 71 at minimum and maximum delays as a function of experimental session. The minimum was always no delay ("0 second"); the different maxima are noted.

Blough, 1959 (p. 156)

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Both birds exhibited striking superstitious behavior during the presentation of the sample and in the delay periods. In neither bird did this behavior occur as two distinct patterns, nor did it appear to “mediate” the discrimination. Bird 64 spent each delay pecking at the top of the sample bar, while Bird 71 pecked abortively at or around the left key. In both birds this behavior developed during the very first day of the experiment and remained substantially unchanged thereafter.

Blough, 1959 (p. 155)

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Research Example

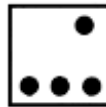
- A few studies have demonstrated that after acquiring TB tacts and intraverbals compared to SB responses that persons with developmental disabilities were more likely to correctly select the items when their name was given. (Sundberg, et al. 1996)
- In addition, Potter et al (1997) demonstrated that college students reported using their TB repertoire to more accurately perform a delayed matching response.
- When they were shown arbitrary configurations of dots matched to flag-like figures and then asked later to choose the correct dot array when re-shown the flag-like figures the subjects indicated that they would tact both figures and intraverbally link them.

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Potter et al., 1997



Goes With



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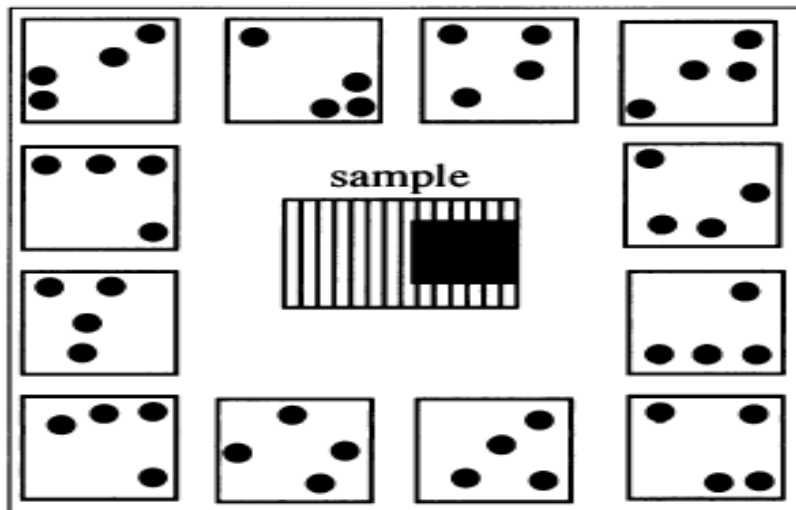


Fig. 1. Illustration of the patterns and screen arrangement used.

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- They then reported when shown the flag- like figure they would tact it as they had before and then tact each of the dot arrays until the intraverbal connection between the two responses evoked the correct selection of the appropriate dot array.
- You can imagine someone saying “ That’s the backward flag that goes with “Y” configuration of dots, no wait, it goes with the backward “L”, that’s it ”.
- Other responses are possible such as self-echoing the invented name of the item that goes with the invented name of the flag-like figure until the echo and the tact can occur while looking at the same array which would be the moment of “recognition” and then choosing it.

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- By analyzing how speaker behavior mediates and evokes listener behavior, an analysis of joint control provides an evidence-based and conceptually systematic explanation of listener behavior, without reliance on cognitive processes and structures.
- Furthermore, an explanation of joint stimulus control falls within the confines of Skinner’s (1957) analysis of verbal behavior, not only with relation to his descriptions of the elementary verbal operants, but also with relation to his descriptions of multiple causation (multiple control) and descriptive autoclitics.

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Development of Joint Control In Children

- By identifying the role of verbal mediation, the analysis of joint control provides a plausible interpretation of the occurrence of generalized responding which unmediated accounts are insufficient to explain (Lowenkron 1984, 1988, 1989, 1991, 1996, 1997, 1998, 2006a, 2006b; Lowenkron & Colvin, 1992, 1995).
- It is suggested that typical children's responding comes under joint control without programmed instruction by parents and teachers.
- Lowenkron (1997, 1998) suggested that by the age of three children have acquired three repertoires, unmediated stimulus selection, echoic, and tact
- Lowenkron proposed that at a certain point in language development these three repertoires begin to interact, resulting in complex linguistic behavior.

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Typical Development of Joint Control

- Michael (1996) and Lowenkron (1997, 1998) suggested that in increasingly complex environments,
 1. The emission of echoic and self-echoic behavior, after a caregiver's instruction to find or retrieve an item, would be reinforced by improved accuracy in locating the named item.
 2. If the child then encounters a nonverbal stimulus that evokes a tact response of the same topography as the simultaneously emitted self-echoic, joint control occurs.
 3. If the child selects that nonverbal stimulus due to previously acquired **unmediated** listener behavior, responding in the presence of the onset of joint stimulus control would be adventitiously reinforced.
 4. Repeated occurrences of this arrangement would lead to generalized responding to joint control events and consequently lead to the performance of various complex behaviors.

[JL Video of Selection](#)

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Joint Control Research with Children with Autism

- This analysis provides the basis from which potential teaching procedures for children with autism can be derived.
- Presently, there are only a published and unpublished applied study on the benefits of joint control training for children with autism.
- Tu (2006) examined the importance of joint control when teaching responses to experimenter vocal requests to both vocal and non-vocal children.
- She found that tact and echoic training were insufficient to produce listener selection responses.
- Only after joint control training did the participants improve their selection response.

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- In an unpublished dissertation, delgi Espinosa (2011) examined the effects of a teaching procedure derived from a joint control analysis on the selection of picture sets composed of color and item combinations for three children with autism.
- The joint control teaching procedures required that participants simultaneously emitted self-echoic and tact responses prior to emitting selection responses.

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degli Espinosa (in preparation)

- Subjects: 5 children with autism, 3 English-speaking, 2 Italian-speaking
- Baseline:
 - Show, eg, a green bottle. "What is it?"
 - Response: "Bottle"
 - "What color?"
 - "Bottle"

We see a tendency for "What---" to control the name of the item (a "label" tact).

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- Intraverbal control: Words that are often heard together or said together are "intraverbally related."
- One word evokes the next, as in a memorized poem, or word associations:
 - "To be or...." (not to be)
 - "Four score and...." (seven years ago)
 - "Bread and..." (butter)
 - "Cheddar..." (cheese)

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- Training of intraverbal control, Part 1:
 - “What is it?”
 - “It’s a bottle”
- First intraverbal:
 - “What is it?” evokes the frame “It’s a —”.
- Second set of intraverbals
 - “It’s a—” evokes a label tact, e.g. shoe.
- At the end of extensive training “It’s a—” exerts intraverbal control over a whole set of possible responses (bottle, shoe, car, etc.)
 - That is, when child says “It’s a—” a variety of possible responses are potentiated, just as “city” evoked a variety of potential responses in the intraverbal game.

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- Summary:
 - “What is it?” intraverbally evokes “It’s a—”
 - “It’s a—” intraverbally evokes a set of labels.
 - The particular object also evokes its label.
 - That tact is emitted under joint control.

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- Training of intraverbal control, Part 2:

- She presented color swatches
- “What color?”
- She then shaped and evoked
 - “Color green,” “Color red,” “Color blue,” etc.
- Result:
 - “What color?” intraverbally evokes the frame “Color ---”.
 - “Color—” intraverbally evokes a wide variety of color tacts.
 - Prevailing stimulus evokes a particular color tact.
 - That tact is emitted under joint control.

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- Now:

- “What is it?” --- “Bottle”
- “What color?” --- “Green”

[CONNOR – COLOR &Name](#)

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- Replicated for
 - “What animal is it?”
 - “What does it say?”
 - “What shape?”
 - “What function?”
- In each case, the procedure quickly leads to correct responding, whereas standard procedures often fail, take longer, or lead to extinction-induced disruptive behavior.
- This example is the least obvious of the procedures I have seen to date.

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Additional pairs

- What is it? **It's a** object name
- What colour? **Colour** green
- What animal? **It's a** cat
- What does it say? **It says** meow
- Who is it? **It's** mummy
- What is **she** doing? **She is** swimming
- What do you **eat**? **Eat** spaghetti
- What do you eat **with**? **With** fork

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Teaching question discrimination to children with autism

- Procedure based on manipulating relevant conditions to evoke intraverbal control between the word “colour” and a colour name (i.e., the example being presented) and the word “number” and a number name (i.e., the example being presented).
- By training responding to single elements using autoclitic frames it may be possible to bring the response under multiple echoic, intraverbal and tact control in a tact conditional discrimination without specifically teaching it.

degli Espinosa and Brocchin (in preparation)

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Procedure: Teaching steps (run concurrently)

1. Echoic priming

- “Colour green”, “colour red”, “colour blue”, etc., and “number 3”, “number 5”, “number 4”, etc., to increase intraverbal control of the verbal stimulus “Colour” and the name of a colour, “number” and the name of a number

2. Establish tacts (or intraverbals if you prefer...) of numbers with the autoclitic frame “Number [X]”

- Stimuli are black numbers on white paper. Ask “What number?” in each presentation. The response is partly an echoic, partly intraverbally controlled, and partly a tact (specific sample), thus establishing multiply controlled responding

3. Establish tact of colour swatches with the autoclitic frame “Colour [X]” (in separate trial blocks from Step 2)

- Ask “What colour?” in each presentation. The response is partly an echoic, partly intraverbally controlled, and partly a tact (specific sample), thus establishing multiply controlled responding

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Procedure: Testing

4. When these groups of tacts are established in this way, begin testing for tact conditional discrimination using a continuous schedule of reinforcement for each correct response
 - a) Run echoic trials as a priming session
 - b) Present five coloured numbers on the table and randomly ask one of the two questions on a single stimulus (do not ask two questions about the same stimulus). Use an intraverbal filler, so when you point to the relevant sample and ask "What number? Say "Number...". The child should then say "Number" and the number name (e.g., "Number three"). Note: The intraverbal filler is used to establish intraverbal control over the whole class with the tact as the specific sample, so it does not function as a prompt for the tact. Use the same procedure for the "What colour?" question, then randomise colour and number questions

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- The results of this study indicated that the joint control training procedures utilized led to correct selection of trained stimuli and generalized responding across novel stimulus sets.
- To extend the research on this topic with children with autism the purpose of the study that follows was to teach children with autism who emitted limited listener response repertoires to select multiple pictures of items from a large array in the order in which they were requested (e.g. "Give me the ball, cup and spoon").

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METHOD

Participants and Setting

- There were three participants in this study.
- All participants demonstrated echoic/mimetic, tact and intraverbal repertoires that fell within the 18-30 month level of the VB-MAPP (Sundberg, 2008).
- All participants were enrolled at a private clinic that provides one-on-one instruction that was guided by the principles of applied behavior analysis and incorporated Skinner's (1958) analysis of verbal behavior.

- Bobby
 - Six-year-old male diagnosed with autism who was enrolled for about 15 hours per week.
 - Non-vocal learner who used manual sign language as his primary means of communication.
- Connor
 - Fourteen-year-old male diagnosed with Pervasive Developmental Disorder (PDD) and Attention Deficit Hyperactive Disorder (ADHD) who was enrolled at the clinic for about 8 hours per week.
 - Vocal learner
- Andre
 - Seventeen-year-old male diagnosed with autism who was enrolled for about 15 hours per week.
 - Vocal learner

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Stimulus Sets

- Choice of stimulus sets of pictures of items was the dependent variable in this study. Therefore, a pool of 12 previously mastered tacts and listener selection responses were combined to form 50 stimulus sets containing three or four pictured items in each set. The number of pictured items within each set varied for each participant based on pre-baseline assessment of skill levels.

Experimental Design

- A multiple probe design across participants was used to examine the effectiveness of joint control training on teaching listener responding (Horner & Baer, 1978).

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Response Definitions and Data Collection

- Two dependent variables in this study:
 - Cumulative frequency of untrained stimulus sets acquired (baseline and generalization).
 - Cumulative frequency of trained stimulus sets acquired (based on daily first trial probes in the training condition).
- **Correct response:** Selecting all pictured items that correspond to the spoken items named by the instructor (i.e., vocal stimulus), in the same order in which they were presented by the instructor; the response was completed within 20 seconds of the presentation of the vocal stimulus and included a full 1 second pause following the selection/delivery of the final item.
- For example, the experimenter said "Give me A, B and C". A correct response was the child handing A, B and C to the teacher in that order within 20 secs that included no attempt to hand over another stimulus for 1sec after the response.

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- **Incorrect response:** Selecting pictured items that did not correspond to the vocal stimulus OR selecting the incorrect number of pictured items OR selecting pictured items that correspond with the vocal stimulus in a different order than which they were presented OR emitting a response beyond the established time criteria (20 seconds) OR initiating a response before the completion of the vocal stimulus OR failing to respond.
- IOA and treatment fidelity measures were all within acceptable ranges.

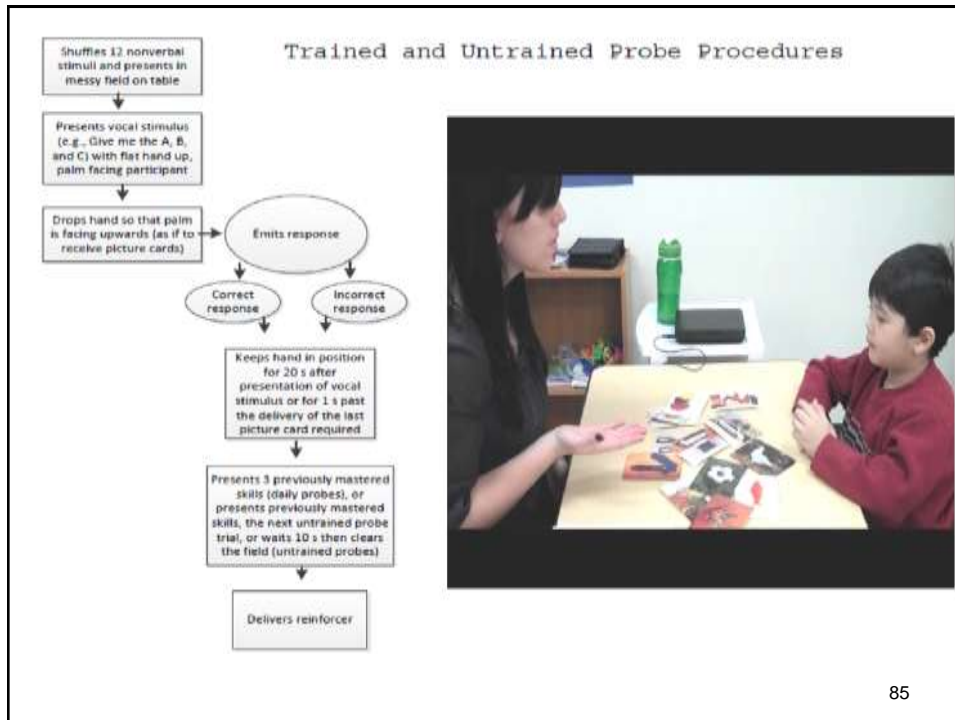
83

PROCEDURES

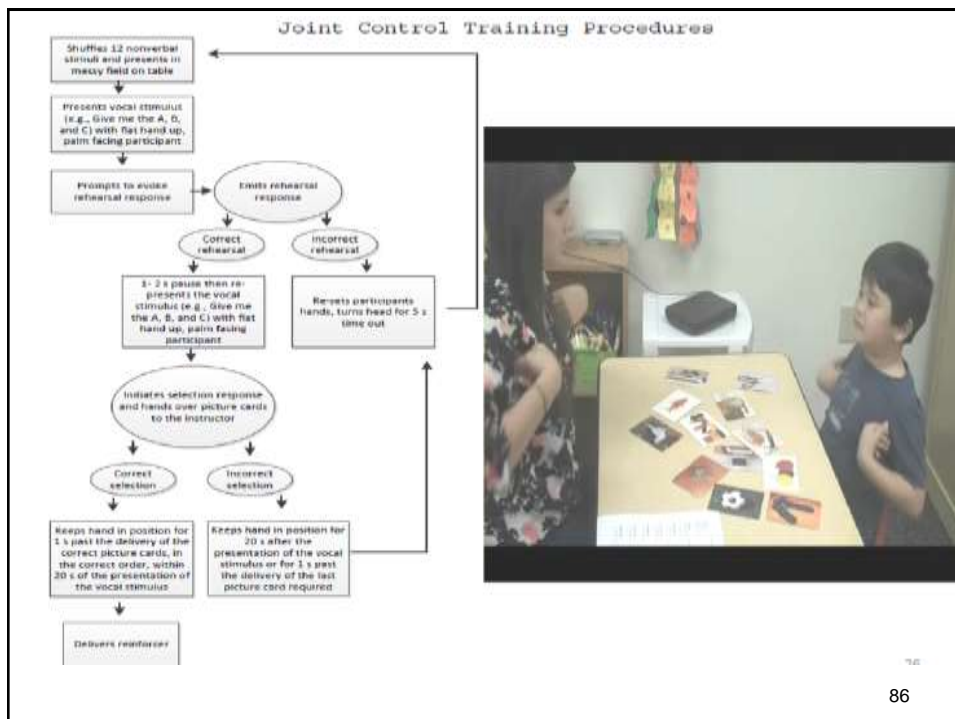
Experimental Conditions

1. Baseline – probes of all 50 sets were conducted during each day of baseline according to the probe procedures described in the next slide. A correct response during any probe during baseline was the criterion for acquisition and the set was removed from the group of 50.
2. Probes for trained and untrained sets occurred each day during treatment. A correct response on the first presentation of a stimulus set was the criterion for acquisition. During training probes acquisition required two consecutive daily probes to meet acquisition criterion.

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General Procedures

- Each time acquisition criteria were met for a trained stimulus set, a probe of all remaining untrained stimulus sets was conducted until all the sets were recorded as either trained or untrained.

VIDEOS OF PROCEDURES

- What follows are video illustrations of each of the phases of the experiment.

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Experimental Conditions

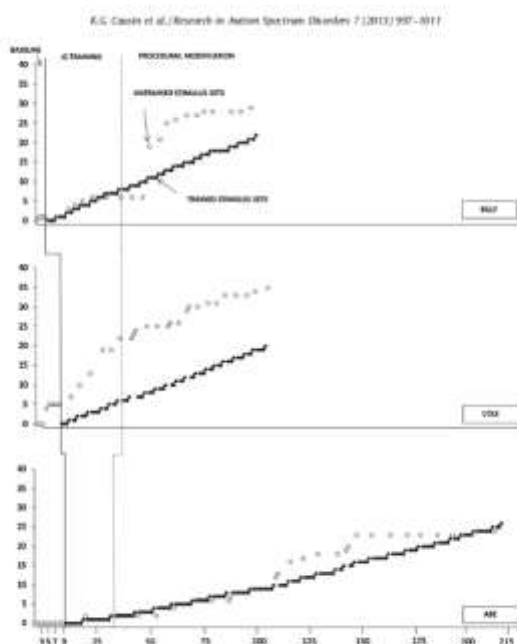
- Baseline Conditions
 - Baseline Procedures ([Bobby Video](#))
- Treatment Conditions
 - Joint Control Training Condition
 - Vocal Learner Teaching Procedures ([Andre Video](#))
 - Non-Vocal Learner Teaching Procedures ([Bobby Video](#))
 - Error Correction Procedures ([Connor Video](#))
 - Joint Control Training with Rehearsal Condition
 - Vocal Learner Rehearsal Training Procedures ([Andre Video](#))
 - Non-Vocal Learner Training Procedures ([Bobby Video](#))

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Results

- In total Billy acquired a 22 trained stimulus sets and 28 untrained stimulus sets across 120 joint control training condition sessions.
- In total, Cole acquired 20 trained stimulus sets and 30 untrained stimulus sets across 96 joint control training sessions.
- Across 206 joint control training sessions, Abe acquired 26 trained stimulus sets and 24 untrained stimulus sets.

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Private Nature of Responses

- The private nature of the jointly controlled responses block direct observation and therefore leads to an interpretive analysis of the role of joint control.
- In this experiment, the children were not required to emit overt tact responses and therefore, the additive effects of the tact response can only be inferred.
- In prior studies however, blocking of one of the responses necessary for joint control substantially degraded correct responding suggesting that covert responses appear to be playing a role in the additive effects of more than one stimulus leading to listener response errors.
- Throughout this study there were instances in which the child emitted the overt response with no requirement or when he failed to emit an overt tact response appeared to interfere with responding leading to response errors.
- Video demonstrations of this follow.

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- Frequently during both daily first trial probes and untrained stimulus set probes, Bobby was observed to respond intraverbally to the teachers vocal stimulus and presence the stimulus through self-mimetic behavior even when he was not explicitly required to do so.

[Bobby Example \(Bobby Video- one rehearsal\)](#)

- Prior to beginning training with rehearsal, Connor did not emit an overt self-echoic response during final trial and untrained probes. Following training with rehearsal, Connor always engaged in a self-echoic rehearsal, even when he was not required to do so by the experimental contingency (i.e. during untrained probes).

[\(Connor Video\)](#)

- Andre engaged in a self-echoic rehearsal during both training and untrained probe conditions. When Andre engaged in the correct self-echoic rehearsal to correct stimulus set, suggesting that the self echoic rehearsal contributed to the correct selection response. [\(Andre Video\)](#)

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Clinical Applications

- In this experiment the emission of a single response topography occurring under two different sources of control (i.e. echoic and tact or mimetic and tact) occasioned selection responses.
- Given this analysis, the onset of joint control was a generic event consisting of the simultaneous control of two discriminative stimuli over a single response.
- The results of this study indicated that joint control training was effective in increasing trained and untrained listener responses for the three participants involved.
- Typical children may acquire this repertoire through exposure to every day contingencies, however, children with autism may require precise teaching to acquire jointly controlled responses.

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- A number of authors have expounded upon the advantages of a joint control analysis, not only as an explanation for complex human behavior (Lowenkron, 1998), but as a means by which to design language training programs for individuals with language deficits and delays. (Causin, Albert, Carbone, Sweeney-Kerwin, 2013; delgi Espinosa, 2011; Michael et al., 2011; Sidener, 2006; Tu 2006).
- As an example of mediated stimulus selection joint control training provides an efficient method of teaching generalized responding to children with autism that would require a virtually impossible number of trials to achieve the same outcome. (Sidener, 2006).

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- Within autism treatment programs, skills that are often acquired under the title of “auditory and visual memory” or cognitive skills may actually be acquired through the unwitting effects of the type of verbal mediation that was explicitly taught in this study.

The list of skills that may be taught using methods derived from a joint control analysis include:

- delayed match to sample
- completing a complex pattern of items,
- finding a previously displayed item within a large array,
- identifying what is missing from a previously displayed array of items,
- following multiple step instructions,
- answering yes or no,
- counting out a specific number of items from a larger set.

[Videos of Clinical Applications](#)

Future Research

- In general, when mediating responses (self-echoic, self-mimetic and tact responses) were overt, correct selection of the stimulus set was more likely. Similar to the studies performed by Gutierrez (2006), Lowenkron, (2006b), DeGraaf and Schlinger (2012), future research should experimentally investigate the individual roles of echoic, self-echoic, and tact responses to provide additional empirical evidence in favor of a joint control analysis

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Multiple Control

- Michael et. Al. (2011) identified joint control as a special case of convergent multiple control, defined as “the convergent control of a response of a particular topography by two concurrent variables” (p,21) .
- Michael, et. al. (2011) and Palmer (2006, 2010) asserted that the convergent control of two or more stimuli extends beyond joint control events and suggested that changes in salutation of response strength may provide a ubiquitous and plausible explanation for the more general phenomena of multiply controlled responses.
- Palmer (2006) suggested that at any given moment interaction with environmental stimuli strengthens a host of possible responses by weak stimulus control or strong competing responses may prevent emission.
- The onset of some additional stimulus, however, may strengthen previously potentiated response forms and cause a discriminable “jump” in response strength, leading to response emission.
- Consistent with Lowenkron’s (1998) analysis, Michael et al. (2011) suggested that the occurrence of joint control is a “discriminable event that would control a selection response” (p.21).

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Primacy of Topography-Based Verbal Behavior

- For one participant the response form was manual sign language, suggesting the applicability of these procedures to non-vocal children for whom alternative communication systems are necessary.
- An important point, however, is that responding to joint control events depends upon topography-based verbal behavior (e.g., vocal, manual sign language, writing) (Lowenkron, 1991).
- Consequently, selection-based methods of communication such as the Picture Exchange Communication System (Bondy & Frost, 2012) or icon selection using a touch screen device preclude the occurrence of responding under the control of joint control events.
- As Lowenkron (1991) stated, “Generalized selection-based verbal behavior is thus dependent on, rather than alternative to, topography based verbal behavior” (p.125).

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The next few slides are from a paper by Dave Palmer (August, 2014) presented at Penn State University

- Many behavior analysts are not aware that there is a thorny problem to be solved and that a consideration of the role of joint control solves it. Certainly the lay person thinks there is nothing to explain: In a matching-to-sample task, we pick the correct comparison because it *matches* the sample (is bigger, is left of, is the square root of, etc.)

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The problem of matching to sample

- In a novel example, how do we *know* that one stimulus matches another, or that it is discrepant?
- Identity is not in *stimuli* but in the common evocative effect of stimuli (ie, joint control).
- With many implications for conceptual interpretations:
 - E.g., RFT places the control of relational behavior in the stimulus. I believe that we must also consider the control arising from the subject's subsequent responses to the stimulus.

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- It is perhaps more plausible to dismiss the concept of "identity" entirely and to assume that we match stimuli according to the discriminated responses they evoke: two stimuli might evoke the same response and therefore be judged identical. If we see a pattern as a star, we might match it with another pattern that we see as a star, even if the stars are different. (It isn't necessary that two fish be identical; as long as we *tact* both of them as "fish," we can match on the basis of our identical responses.
- But response-produced stimulation is still stimulation; we are left with the puzzle of how to tell that two stimuli, response-produced or otherwise, have "matched," in the absence of a specific history of matching such stimuli. The problem is exactly as intractable as before.
- Lowenkron's analysis solves the problem in a general way that is independent of the particular stimuli in any example.

[Experiment 1](#)

[Experiment 2](#)

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Finally, Palmer (2006, p.214) discusses the important role joint control plays in the control of human behavior and notes the general lack of recognition it has previously been given by behavior analysts:

“Joint control is a tool in the workshop of the behavior analyst who would understand complex behavior. It is not a new phenomenon, nor does an analysis of joint control invoke new principles. It has been lying in the toolbox all along, but we are only beginning to appreciate its role in the control of human behavior. I believe that it will have a distinguished future.

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Tacting the Presence or Absence of Joint Control by Saying "Yes" or "No"

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TEACHING “YES” AND “NO”

- Two previous studies taught children with autism to emit “yes” or “no” responses.
- Neef, Walters, and Egel (1984)
 - Used mand-to-tact stimulus control transfer procedures
 - Taught subjects to tact “yes” or “no”
 - Generalized responding to novel stimuli was not observed
- Shillingsburg, Kelley, Roane, Kisamore, and Brown (2009)
 - Used an echoic prompt and prompt fade sequence
 - Taught “yes” and “no” responses as mands, tacts, and intraverbals
 - Generalized responding was observed within but not across operant classes

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- Neither of these studies provided an analysis of why generalized responding was or was not observed.
- Furthermore, neither study provided a behavioral conceptual analysis of yes and no responding.
- The only way to meet these two objectives is to analyze the role of joint stimulus control over mediating verbal behavior that evokes the descriptive autoclitic (autoclitic tact) responses of yes or no.

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PURPOSE OF CURRENT STUDY

- Therefore, the purpose of this study was
 - To provide a thorough, and strictly behavioral, conceptual analysis of “yes” and “no” responding as tacting the presence or absence of joint control.
 - To extend the literature on joint control by teaching speaker, rather than listener, behavior.
 - To extend the literature on teaching “yes” and “no” responding to children with autism.

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METHODS

PARTICIPANT AND SETTING

- There was one participant in this study.
- Andrew
 - 14-year-old male
 - Diagnosed with PDD-NOS
 - VB-MAPP Assessment (Sundberg, 2008): mand, tact, listener responding, and intraverbal repertoires within the 30- to 48-month range
 - Received instruction for five, 3-hour sessions per week
- Sessions were conducted at a private educational setting that provides one-on-one intensive instruction guided by the principles of ABA and Skinner’s (1957) analysis of verbal behavior.

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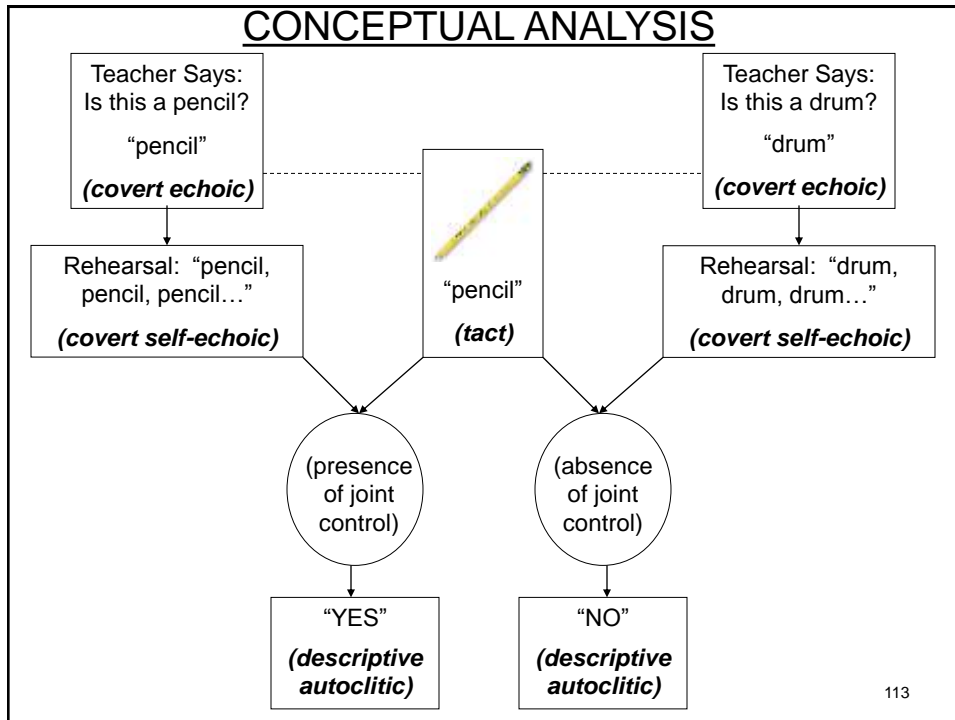
GENERAL OVERVIEW OF PROCEDURES

- This study was designed to teach the participant to vocally answer (tact) “yes” or “no” in response to questions about a non-verbal stimulus. For example:
 - When shown a pencil and asked “Is this a pencil?” the participant would say “yes.”
 - When shown a pencil and asked “Is this a drum?” the participant would say “no.”
- Stimuli for which the participant reliably tacted the name of the item were selected.
- For each stimulus, 20 questions were developed, 10 “yes questions” and 10 “no questions.”
- All “no questions” were different.

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- The study was sequenced as follows:
 - Baseline probes – 5 untrained stimuli
 - 1st stimulus trained
 - Untrained stimulus probes – 4 untrained stimuli
 - 2nd stimulus trained (plus weekly maintenance probes started)
 - Untrained stimulus probes – 3 untrained stimuli
 - 3rd stimulus trained (weekly maintenance probes continued)
 - Untrained stimulus probes – 5 untrained stimuli
 - 4th stimulus trained (weekly maintenance probes continued)
 - Untrained stimulus probes – 5 untrained stimuli
 - 5th stimulus trained (weekly maintenance probes continued)
 - Untrained stimulus probes – 5 untrained stimuli
 - 6th, 7th, and 8th stimuli trained consecutively (weekly maintenance probes continued)
 - Untrained stimulus probes – 10 untrained stimuli
 - 9th, 10th, and 11th stimuli trained consecutively (weekly maintenance probes continued)
 - Untrained stimulus probes – 10 untrained stimuli

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DEPENDENT VARIABLE AND RESPONSE DEFINITIONS

- The dependent variable was the cumulative frequency of acquired untrained and trained stimuli.
- Acquisition criteria for untrained stimuli was at least 18/20 questions answered correctly during one baseline or untrained stimulus probe.
- Acquisition criteria for trained stimuli was at least 18/20 questions answered correctly during two consecutive training sessions.

- Correct Response
 - Latency within 3 seconds
 - Said “yes” when joint control was present
 - Said “no” when joint control was absent
- Incorrect Response
 - Latency beyond 3 seconds
 - Said “no” when joint control was present
 - Said “yes” when joint control was absent

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DATA COLLECTION AND INTEROBSERVER AGREEMENT

- Data were recorded by scoring each question as correct (+) or incorrect (-).
- Reliability of these data was assessed throughout the study and IOA was never below 90%

TRAINING AND TREATMENT FIDELITY

- A task analysis of the procedures was used to train instructors prior to beginning this study and to assess treatment fidelity throughout the study.
- Treatment fidelity was never below 92%.

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EXPERIMENTAL DESIGN AND SEQUENCE

- An ABC design incorporating multiple probes (Horner & Baer, 1978) was utilized.

Baseline Condition

- Probes were conducted for 100 questions (20 questions for each of 5 untrained stimuli – pencil, dinosaur, Play-doh, fork, and block).
- [Video Demonstration of Procedures](#)

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Question	Correct/Incorrect
Is this a pencil? ("yes")	+ -
Is this a pickle? ("no"-pencil)	+ -
Is this a dinosaur? ("yes")	+ -
Is this a calendar? ("no"-pencil)	+ -
Is this a pretzel? ("no"-block)	+ -
Is this playdoh? ("yes")	+ -
Is this a TV? ("no"-dinosaur)	+ -
Is this a block? ("yes")	+ -
Is this a guitar? ("no"-block)	+ -
Is this a turtle? ("no"-fork)	+ -
Is this playdoh? ("yes")	+ -
Is this playdoh? ("yes")	+ -
Is this a drum? ("no"-pencil)	+ -
Is this a dinosaur? ("yes")	+ -
Is this a tissue? ("no"-block)	+ -
Is this a pool? ("no"-fork)	+ -
Is this a movie? ("no"-block)	+ -
Is this a block? ("yes")	+ -
Is this a book? ("no"-playdoh)	+ -
Is this a pencil? ("yes")	+ -
Is this a block? ("yes")	+ -
Is this a raisin? ("no"-pencil)	+ -

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Multiple Exemplar Training Condition

- The first training stimulus was randomly selected from all stimuli that were not acquired during the baseline probes.
 - The 20 questions used during training were the same as those that had been used during the baseline probe.
 - Each day these questions were presented in a different randomized order that was adjusted to ensure that no more than three consecutive questions had the same answer.
- [Video Demonstration of Procedures](#)

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Question	Correct/Incorrect
Is this a marker? ("yes")	+ -
Is this a shovel? ("no")	+ -
Is this a marker? ("yes")	+ -
Is this a zebra? ("no")	+ -
Is this a marker? ("yes")	+ -
Is this a marker? ("yes")	+ -
Is this a Play-doh? ("no")	+ -
Is this a bike? ("no")	+ -
Is this a sandwich? ("no")	+ -
Is this marker? ("yes")	+ -
Is this glue? ("no")	+ -
Is this a marker? ("yes")	+ -
Is this a book? ("no")	+ -
Is this a fence? ("no")	+ -
Is this a marker? ("yes")	+ -
Is this a marker? ("yes")	+ -
Is this a marker? ("yes")	+ -
Is this a donut? ("no")	+ -
Is this a marker? ("yes")	+ -
Is this an Ipod? ("no")	+ -

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Probes of Untrained Stimuli

- Once a trained stimulus was acquired, probes of untrained stimuli were conducted to assess responding to novel stimuli and questions.
- Questions were developed and probes were conducted according to baseline procedures.
- Following these probes, the next training stimulus was randomly selected from any untrained stimuli that hadn't met acquisition criteria.

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Maintenance Condition

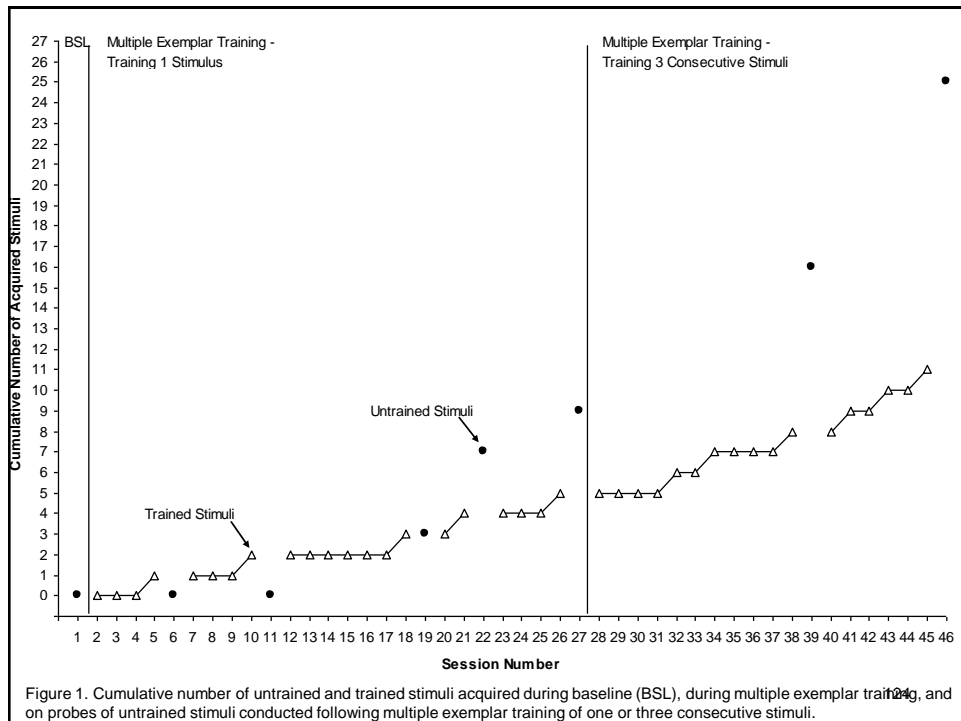
- Once a trained stimulus was acquired, weekly maintenance probes were conducted.
- Each week the same 20 questions were presented in a different randomized order.
- Probes were conducted according to baseline procedures.

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RESULTS

- Figure 1 shows the cumulative number of untrained and trained stimuli that were acquired across sessions and conditions.

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- Sixty-six maintenance probes were conducted across the 11 trained stimuli that were acquired.
- Maintenance data showed that correct responding to “yes questions” was maintained at 96% and correct responding to “no questions” was maintained at 83%.
- [Video Demonstration of Untrained Probes Following Joint Control Training](#)

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DISCUSSION

- Following training Andrew demonstrated correct “yes” and “no” responding to both trained untrained stimuli.
- Early on Andrew frequently alternated his responses (i.e., “no, yes, no, yes, no, yes”) regardless of the questions being asked or the stimuli displayed.
- This was likely due to a history of self-corrected responses (e.g., “no...yes”) having been reinforced.
- Another possible explanation for this early responding is that Andrew’s correct responses were the result of chance or guessing.

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- Subsequent responding demonstrates a consistent increasing trend in the rate of acquisition of untrained stimuli.
- This suggests Andrew's "yes" or "no" responding was brought under sources of stimulus control that were common to all trials (Lowenkron & Colvin, 1992).
- His behavior of saying "yes" was brought under the discriminative stimulus control of tacting the presence of joint control.
- His behavior of saying "no" was brought under the discriminative stimulus control of tacting the absence of joint control.
- Andrew learned to "tacting the nature of control (joint control or non-joint control) over some feature of his own behavior with respect to the stimuli" (Lowenkron & Colvin, 1992, p. 9).
- By using an analysis of joint control, a strictly behavioral, concise, and parsimonious conceptual analysis can account for the untrained responding that was observed.
- It is not necessary to rely on cognitive explanations, such as the need to develop knowledge of concepts, meanings, or rules, to account for these responses.

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- This has important implications for teaching other complex speaker repertoires to children with autism.
- Studies that investigate the teaching of these and other complex language skills will be an important direction for future research.
- In addition, future research should look to replicate this study while expanding upon its limitations.
 - Only one subject
 - ABC design
 - Baseline probes not conducted for all stimuli
 - Only one set of baseline probes conducted
- Despite these limitations, however, this study extends the current research on joint control as no published studies thus far have demonstrated how an analysis of joint control can be used to teach speaker behavior to children with autism.
- Furthermore, it extends the literature on teaching tacting "yes" and "no" to children with autism, by providing a concise, parsimonious, and strictly behavioral analysis of the stimulus control for these responses.

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THE END

Palmer on Joint Control

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Generalized Multiply Controlled Verbal Behavior”.