The Role of Joint Control in Teaching Listener Responding to Children with Autism

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Review of Listener/Speaker Behavior

- 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 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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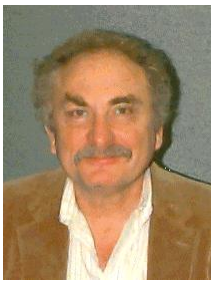
- Schlinger argued that, in fact, listening and speaking may not be functionally different, "**In other words, the listener also behaves verbally when he or she is said to be listening**" (Schlinger, 2008, p.150).

- 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 behaviors, 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).



- 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^Ds control a response of a common topography. It is an example of multiple control.

EXAMPLE

President of the United States

Shot and killed in 1865

- Let's do an activity that will illustrate the role of joint control in listener responding.

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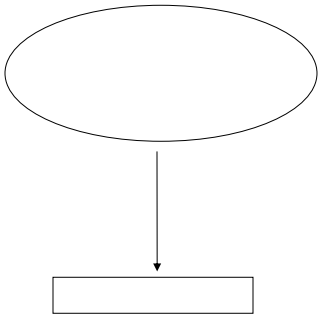
An Example of Joint Control



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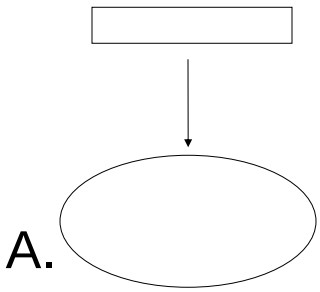
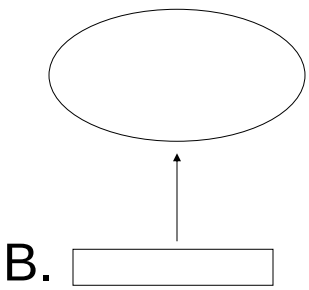


A.



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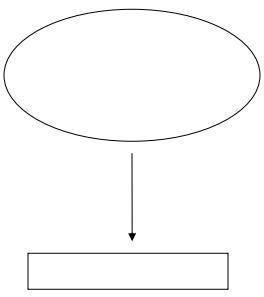

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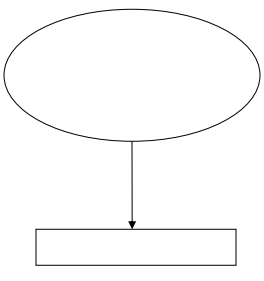

D.

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Steps to Selecting the Correct Response

LISTENER is shown the sample non-verbal stimulus

↓

LISTENER/SPEAKER describes/names the sample non-verbal stimulus:
"horizontal oval, space, down arrow, space, horizontal rectangle"
(TACT)

↓

LISTENER/SPEAKER rehearses the ***TACT*** during the delay period:
"horizontal oval, space, down arrow, space, horizontal rectangle"…"horizontal oval, space, down arrow, space, horizontal rectangle"…"horizontal oval, space, down arrow, space, horizontal rectangle"…
(SELF-ECHOIC)

↓

LISTENER/SPEAKER scans the array of comparison non-verbal stimuli and describes/names each:

A. "horizontal rectangle, space, down arrow, space, horizontal oval" ***(TACT)***

B. "horizontal oval, space, up arrow, space, rectangle" ***(TACT)***

C. "horizontal oval, space, down arrow, space, horizontal rectangle" ***(TACT) + (SELF-ECHOIC)***

D. "horizontal oval touches down arrow touches horizontal rectangle" ***(TACT)***

↓

TACT + SELF-ECHOIC jointly controls selection response of comparison stimulus C.

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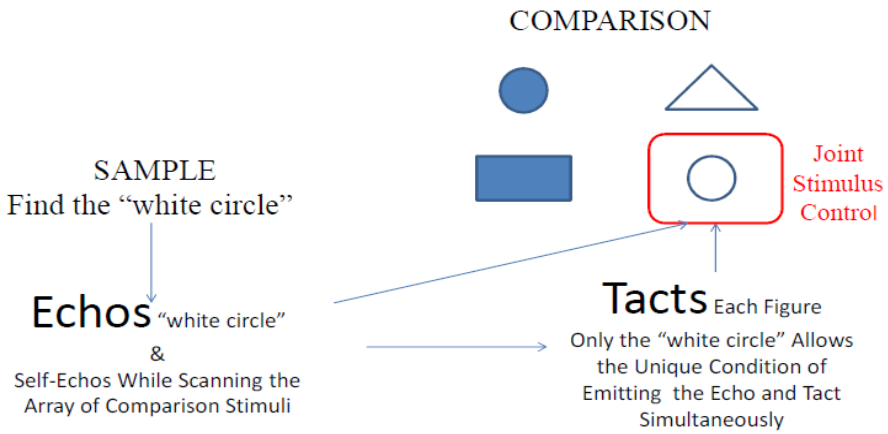

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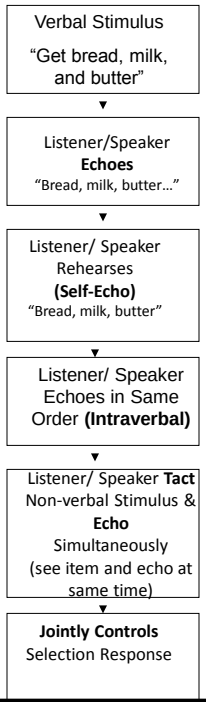
JC Activity
(Potter Example)

Multiple Step Instructions



Circle over square EX

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- Through this analysis, it is easily seen that the listener response of selecting the correct comparison stimulus was **dependent upon speaker behavior, specifically tact and self-echoic responses.**
- If the listener did not already have **strong tact and self-echoic repertoires**, it would be extremely difficult, if not impossible, for this type of delayed listener response to occur without direct teaching of every discrimination.
- However, a verbal repertoire and the mediating effects of joint control make learning untaught discriminations possible
- This suggests that complex listener behavior is dependent upon a speaker repertoire (Schlinger, 2008).
- Blough (1959) demonstrated something very similar to this with pigeons in a delayed match to sample experimental preparation.

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- During the delay period the pigeons which engaged in stereotypical behavior (analagous to invented gestural signs) were more like to emit correct matching responses than those which failed to engage in specific topographical responses during the delay.
- 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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- 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 at least 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 of children,

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, the conditions for joint control occurs.
3. If the child selects that nonverbal stimulus due to previously acquired listener behavior relative to that stimulus, 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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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)

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 couple of published studies and one 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.
- The results of this study indicated that the joint control training procedures led to correct selection of trained stimuli and generalized responding across novel stimulus sets.
- The purpose of the study that follows was to extend the research by teaching children with autism with limited listener 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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The role of joint control in teaching listener responding to children with autism and other developmental disabilities☆

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ABSTRACT

This study evaluated the effectiveness of a teaching procedure derived from the analysis of joint control in increasing listener responses for three children with autism using a multiple probe design across participants. One nonvocal and two vocal children with autism were taught 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") using the joint control teaching procedure. The effect of these procedures on the emission of accurate selection responses to both trained and novel stimulus sets was measured. The results indicated that listener responses to trained stimuli increased following the implementation of the independent variable and untrained responses across novel stimulus sets also emerged. Implications for designing language training programs for children with autism based on an analysis of joint control are discussed.

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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 (1957) analysis of verbal behavior.

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- 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

- Selection 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 the echoic repertoire.

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 number of untrained stimulus set selections acquired (baseline and generalization).
  - Cumulative number of trained stimulus set selections 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 and handing over of the final item in a set.

- 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 or attempting to hand over a picture during the final one second time delay before the experimenter removed her hand.

- IOA and treatment fidelity measures were all within acceptable ranges

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PROCEDURES

Experimental Conditions

1. Baseline – Twelve (12) pictures of objects were configured into 50 sets of 3 or 4 pictures each. 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 recorded as untrained and removed from the group of 50.

2. Probes for trained sets occurred each day during treatment. During training probes acquisition required two consecutive correct daily probes to meet acquisition criterion. Once a set met acquisition criteria the remaining untrained sets were probed for generalized responding.

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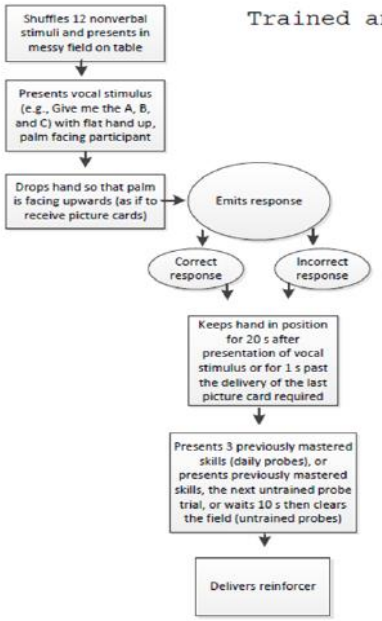
Trained and Untrained Probe Procedures



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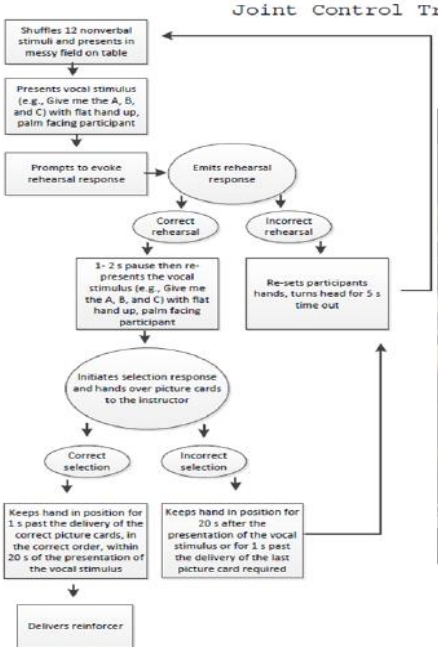
Joint Control Training Procedures



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General Procedures

- **Vocal and gestural prompts for the rehearsal response were systematically faded.**
- 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)
  - Training Rehearsal (self-echoic)
    - Vocal Learner Rehearsal Training Procedures (Andre Video)
    - Non-Vocal Learner Training Procedures (Bobby Video)

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Results

- In total Billy acquired 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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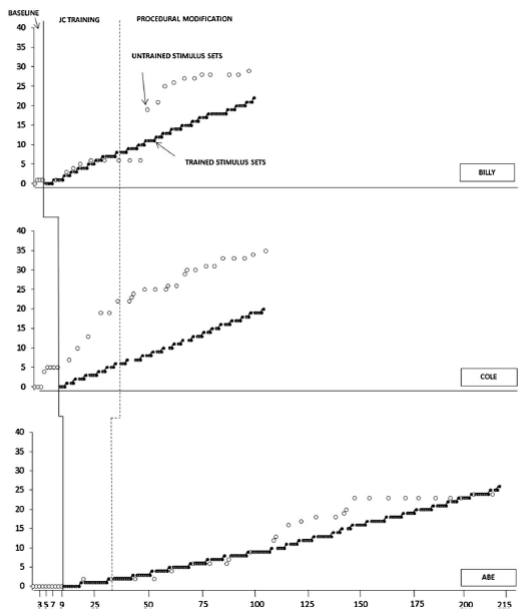

Fig. 4. The cumulative number of trained and untrained stimulus sets acquired during baseline and joint control training for Billy, Cole, and Abe.

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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 of the stimulus through self-mimetic behavior even when he was not explicitly required to do so.
  Bobby Example (Bobby Video- one rehearsal)
- During baseline and before joint control training Connor did not emit an overt self-echoic response. 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). It appears he learned to emit the "strategy" that had been selected by more effective outcomes,i.e., correct selection of multiple items.
  (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 he almost always selected the correct stimulus set. When his rehearsal was incorrect or he failed to rehearse he frequently selected the incorrrect array. (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

- . 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 saltation 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 but 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 may preclude the occurrence of responding under joint stimulus control.
- As Lowenkron (1991) stated, "Generalized selection-based verbal behavior is thus dependent on, rather than an alternative to, topography based verbal behavior" (p.125).

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The next few sides 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.

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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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