

## Joint Control

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## Terminology

- Response
  - Simply any unit of behavior, not necessarily in "response" to something that evokes it. A vestige of the study of reflexes, when all behavior was thought to be evoked by a prior stimulus.
  - Term became obsolete with Skinner's formulation of operant behavior, which could vary in strength in a constant environment according to contingencies of reinforcement, but the term remained in use.
- Contingencies of reinforcement
  - The conditions under which reinforcement is delivered. The word *contingency* refers to an if...then... relationship: If you press this button, the fan will turn on.
- Stimulus
  - Any environmental event or state of affairs that affects behavior. A load sitting on your kitchen table is a stimulus. The salt shaker next to it might or might not be a stimulus. (That is, you might not notice it or be affected by it in any other way.)
    - Note that stimuli are also produced by our own behavior (I can feel my muscles tensing) or by events inside our bodies (my left knee hurts).

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## Terminology cont'd.

- "Discriminative" stimulus
  - A stimulus that controls behavior because in the past it has signaled the availability of reinforcement.
  - In the subsequent discussion, the terms *stimulus* and *discriminative stimulus* will be used interchangeably.
- Reinforcement
  - When a behavior is reinforced in the presence of a discriminative stimulus, it becomes more likely to occur in the future in the presence of that stimulus.
  - So presenting a discriminative stimulus makes the behavior more likely to occur.

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## Terminology cont'd.

- Stimulus Control
  - Our use of the word *control* is also a historical vestige. It simply means *influence*. A "stimulus" is said to "control" a "response." This just means that in the presence of some event or state of affairs, some behavior is more likely to occur than in the absence of that event or state of affairs. We say that the red light "controls" the response of stepping on the brake pedal.
  - We use the terminology of "control" even when the influence is partial or inconsistent. We say "Please pass the salt" when
    - » A) A salt-shaker is present
    - » B) Someone is closer to it than we are
    - » C) Our mashed potatoes are bland (for example)
 We need at least those three conditions, but we would say that each of the three "stimuli" "controls" the "response" in the sense that it influences the probability of emitting the behavior.

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## Terminology cont'd.

- Response strength
  1. The amplitude of behavior: We can shout, assert, suggest, falter, whisper, or speak silently.
  2. The probability that we will emit the behavior at all. This can vary from zero to one, depending on one's history, the panorama of stimuli, competing behavior, and other variables. E.g.:
    - Who was Napoleon's wife's cousin? (Zero)
    - Who was Nixon's first vice president? (Ooh ooh! I know this... It's on the tip of my tongue! It begins with an "S")

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- Notice that in the latter case (Wait wait...Don't tell me!) we can "feel" the strength of the response, even though we don't know what it is!
- That is, we can discriminate the difference between a weak latent response and a strong latent response.

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## The additivity of response strength

- When two or more variables evoke a response of the same topography, response strength increases. "Pass the salt" becomes increasingly likely as
  - 1) A salt shaker is present
  - 2) A person is present
  - 3) Our food is bland
- This point is so important that I will illustrate it with an example

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## The Intraverbal Game I

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## Intraverbal Game II

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## Intraverbal Game III

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## III-B

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## III-C

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- The game illustrates the additivity of response strength:
  - “City” strengthens a variety of responses
  - “President” strengthens a variety of responses
  - But neither one alone is likely to evoke “Washington.”
  - But all of the stimuli together make the response almost inevitable.

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## Multiple control

- These examples all illustrate *multiple control*, the simultaneous effect of many variables on a common response (technically on responses with a common topography).

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## Multiple control is ubiquitous

- When one is in a familiar context, and in the presence of a familiar audience, many verbal responses will be strong concurrently, and any one of them is likely to have been potentiated by more than one variable.
- Behavior is highly competitive. The response that occurs at any time is (usually) just the strongest of a host of competing responses.
- All verbal behavior, to varying degrees, is evoked by concurrent variables (Pass the salt).

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- The skillful use of multiple control underlies humor, poetry, art, and great literature:
  - The poet evokes a symphony of behavioral responses in the listener.

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Golden lads and girls all must  
As chimney-sweepers, come to dust.  
*Cymbeline*

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## A page from Shakespeare's notebook:

- We all end up dead sooner or later. —
- Live it up kids, you're gonna be worms' meat some day.
- ~~Blond boys and girls are going to die too, just like brunettes. Not to mention chimney-sweepers.~~
- Objective consideration of actuarial evidence compels the conclusion that *homo sapiens* of every age, no matter what the state of vigor at the time of baseline observation invariably reach a state at which all metabolic function ceases. (JEAB draft, 1641).

Golden lads and girls all must.  
As chimney-sweepers, come to dust.

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## Joint control defined

- Joint control defined is just a special case of multiple control:
  - Multiple control: The control of a single topography of behavior by many variables simultaneously.
  - Joint control: The control of a single topography of behavior by two variables simultaneously. \*\*\*

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The response of saying "Bill Clinton" is jointly evoked by the picture and partly by the printed words. Either stimulus alone would evoke the response, but it is especially strong because of the combined effect of the two sources of control (joint control).



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- Given that "multiple control is ubiquitous," how can joint control be of any interest whatsoever?

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## Transition is the Key

- There are certain conditions under which the change from unitary control to joint control signals that something important has happened.
- Most of us learn to recognize when this has happened and exploit it.
- Autistic kids (often) do not.

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- When we are searching for something and then find it, stimulus control jumps from unitary control to joint control.
- That is, we "recognize" that we have found it. (Eureka!)
- This recognition response is triggered by the onset of joint control.
- Such recognition responses underlie many cognitive phenomena.

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– What's new:

- The claim that the onset of joint control in certain distinctive contexts (problem solving, memory, matching, searching), is discriminable and can serve as a controlling variable for subsequent behavior.

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## Examples

- Taken from (or inspired by) the work of Barry Lowenkron (conducted from 1984-2006). \*\*\*He initially conceived of joint control narrowly as the joint effect of
  - 1) A rehearsed response (called a "self-echoic")
  - 2) A label or description (called a "tact")
- Most of the research on joint control has been done by Lowenkron and his students and has been restricted to self-echoics and tacts.
  - But we will see that many other kinds of relationships can exemplify joint control as well.

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## Find 3914061

27

- |            |            |
|------------|------------|
| a) 3906861 | b) 3914161 |
| c) 3194067 | d) 3914063 |
| e) 3914064 | f) 3914061 |
| g) 3914160 | h) 3914016 |
| i) 3914116 | j) 3914066 |
| k) 3941160 | l) 3914016 |
| m) 3914016 | n) 3914051 |

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## We have learned a strategy for such tasks:

When we see "Find 3914061," we rehearse it: "3914061.....3914061.....3914061"

When we see the list of numbers, we read them, one at a time: "3906861"

Outcome:

"3914061...3906861....no match"

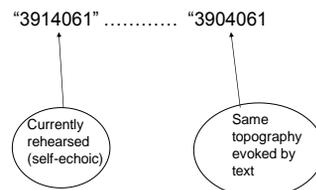
"3914061...3914060....no match"

"3914061...3904061....match!"

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## Lowenkron (1998)

"Joint control occurs when the currently rehearsed topography of a verbal operant, as evoked by one stimulus, is simultaneously evoked by another stimulus."



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## Lowenkron's definition continued

"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."

"3914061" ... "3904061" → (Makes correct choice: "f!")

Joint control of  
same response  
by two stimuli

Evokes,  
ie, "sets the  
occasion for"

Response appropriate  
to this relation (correct  
selection)

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- Two responses of the same topography:
  - In this example: self echoic & textual responses (Skinner's terminology)

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## Other examples

- Find "dot, oh, bar, dot, bar"

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. O . \_ . . \_  
 . O \_ . \_  
 .. O . \_ .  
 . O . \_ . \_ \_

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- Two responses of the same topography:
  - In this example: self echoic & tact responses

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## Find the Fibonacci series:

- 1, 2, 4, 8, 16
- 0, 1, 1, 3, 4, 7, 12
- 1, 2, 3, 5, 7, 12
- 0, 1, 1, 2, 3, 5, 8, 13
- 0, 1, 2, 3, 5, 8, 13

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- Two responses of the same topography:
  - In this example: textual & Intraverbal responses

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## Why do we care?

- Children with disabilities often have difficulty in matching tasks, delayed matching tasks, and symbolic matching tasks, and these tasks are often components of other complex behavior.
  - “Chris, please go to the kitchen and bring back a cup, a spoon, and a napkin.”
  - Chris goes to the kitchen.
  - ...and comes back empty-handed.

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In delayed matching we select the correct comparison after a delay



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## Delay interval

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## Comparisons



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## Sample

bix

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## Delay interval

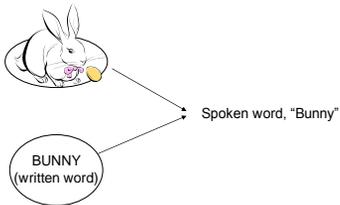
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## Comparisons

dix		xid		box
		xib		dik
dax		bik	bix	kid
fox		bid	fix	xif

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In symbolic matching, a sample and a comparison evoke a common response.



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- Children with disabilities often fail such tasks because
  - (a) One of the two sources of control fails
  - (b) The onset of joint control has not become a discriminative stimulus for a selection response

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## Or, to put it in English:

- They might fail to rehearse
- They might fail to label
- They might fail to notice the coincidence when they see the item they are rehearsing.

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## But they can be trained.

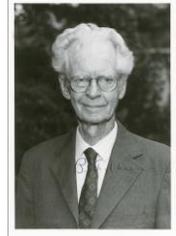
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## A bit of history

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## The first known mention of the concept of joint control in the behavioral literature:

- When we are trying to find a name on a list, we may repeat the name to ourselves – Jones, Jones, Jones – as we run down the page. In this way we use self-echoic sources to supplement the textual response. (Skinner, 1948, p.88)



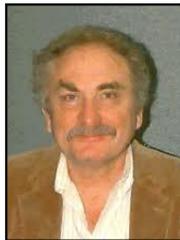
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## History Cont'd.

\*\*\*Barry Lowenkron, professor emeritus at Cal State Los Angeles, coined the term “joint control.”

He rediscovered the concept, independently of Skinner, 40 years later.

He demonstrated its utility in applied settings, popularized the concept, and discussed its generality.



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- Lowenkron proposed that it was the concurrent control by two variables, of two responses with a common topography, namely tacts and self-echoics, that was responsible for generalized matching.
- He found that only when both sources of control were established would children match (particularly in delayed matching tasks).

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- Lowenkron:
  - Without joint control, we would have to train every possible permutation of behavior separately: Go to the kitchen and fetch
    - a plate and spoon
    - a plate and a fork
    - a fork and a knife
    - a knife and a spoon
    - a cup and a plate
    - a knife and a cup.....
- It is hard for a typical adult to grasp that this is so. We exploit joint control so effortlessly that we are unaware that we are doing anything at all.

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- 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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## Illustrative example from Lowenkron (1988)

Subjects were four teen-agers, 2 boys, 2 girls, with unspecified developmental disabilities. All had IQs below 40. Two had a vocabulary of only a few words. So none of them were able to use verbal rehearsal strategically.

The task was to observe a sample stimulus, wait for a few seconds, and then pick that stimulus from an array of four stimuli.

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## Sample stimulus



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## Delay interval (from 4 to 10 seconds)

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## Comparison stimuli



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## Results

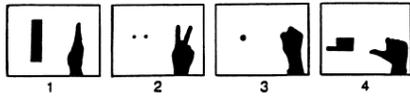
- None of the teens could match any better than chance.

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## Joint Control Procedure

- (1) Train a distinctive hand gesture to each stimulus.
- (2) Train children to tact the sample, that is, to make the hand gesture when the sample appeared.
- (3) Train children to hold the gesture throughout the delay interval ("rehearsal")
- (4) Train the children to hold the gesture up to each comparison.
- (5) Prompt selection response when joint control occurs
- (6) Deliver reinforcer
- (7) Repeat

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The four possible stimuli, and the corresponding signs.

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## Results and interpretation

- Results:
  - When the hand-sign was preserved over the delay interval, correct matching occurred.
- Interpretation: When the comparison stimuli were presented, each comparison tended to evoke a particular hand-sign. Only one of those hand-signs was currently being “rehearsed.” Consequently, joint control of the hand-sign occurred when the child held his hand up to the correct comparison. That was the signal to make a selection response (pointing to correct stimulus).



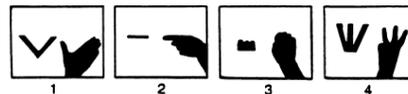
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## Generalization

- When a set of four novel stimuli were tested, 3 subjects showed no generalization at all.
- One subject use the hand signs he had learned previously and got about half of the trials correct. That is, he used a hand-sign to mediate the delay (of only 4 seconds), but as the hand sign did not effectively enter into joint control with the comparison stimuli, it was only partially effective.

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## Training of new mediating responses to the new stimuli



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## Results

- Without further training, 3 of the 4 subjects performed perfectly on the new task. That is, once they had a “label” that they could “rehearse” (a hand-sign they could hold), they did so spontaneously.
- The fourth subject failed to maintain his hand-signs throughout the interval on many trials. When he did maintain them, he was correct.
- Thus Lowenkron’s joint control interpretation was fully supported in this study.

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- Note that, 3 of the 4 kids learned the strategy of exploiting joint control:
  - They generalized from the training procedures to a novel problem.
  - Is it not possible that they went on to exploit this strategy in other aspects of their lives?

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- The previous study was replicated by Tu (2006) in two experiments explicitly with children with autism.
  - In an experiment with verbal children, self-echoic mediation was employed.
  - In an experiment with non-verbal children, hand-signs were used.
  - Results were comparable to those of Lowenkron (1988).
- Tu's study was extended by degli Espinosa to color-item combinations rather than simple tacts (labels) with children with autism.

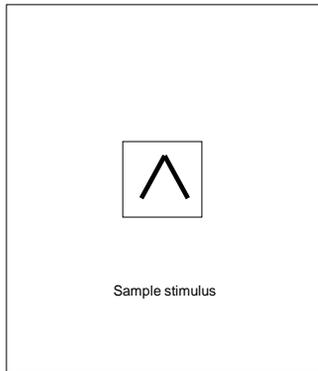
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## A 2<sup>nd</sup> example: Lowenkron, 1984

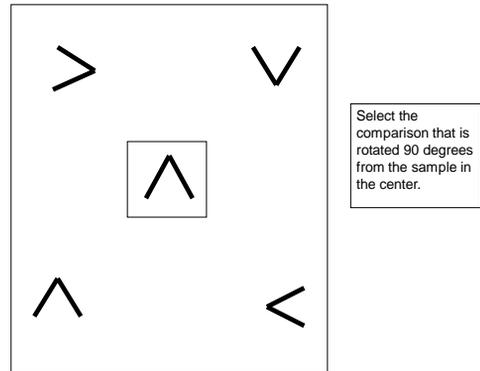
Replicated and extended by Sidener & Michael, 2006

- Subjects:
  - Five typically developing very young children (3-5 yrs.)
- Task:
  - Given an array with one sample and four comparison stimuli, simultaneously presented, pick the comparison that is the same as the sample but rotated 90-degrees clockwise.
- Stimuli:
  - A variety of symmetrical abstract shapes were used. The simplest and most intuitive (to an adult) was a set of arrow-heads.

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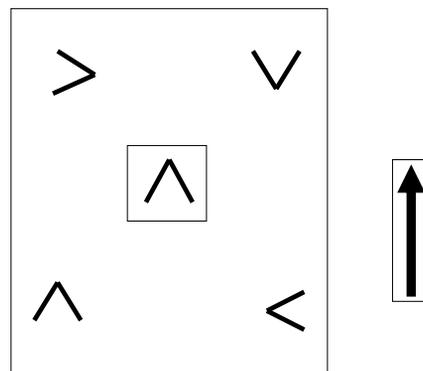
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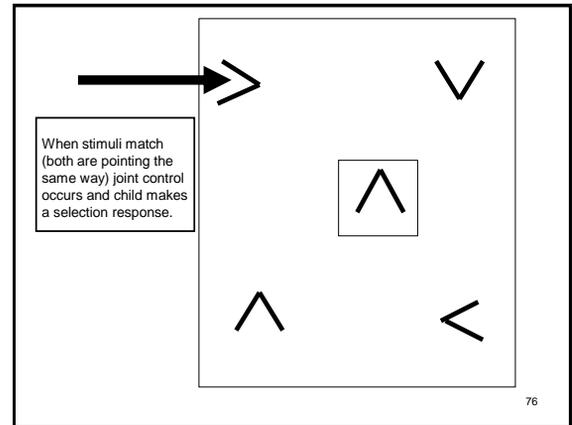
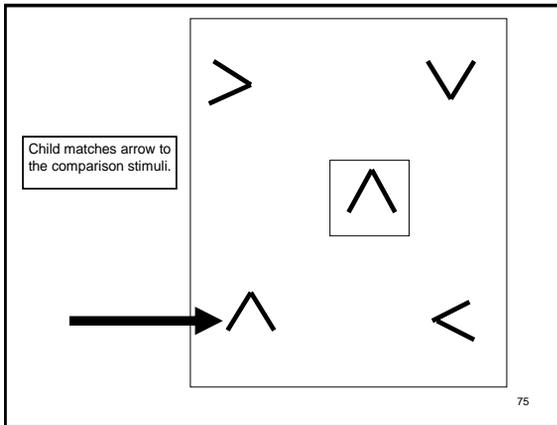
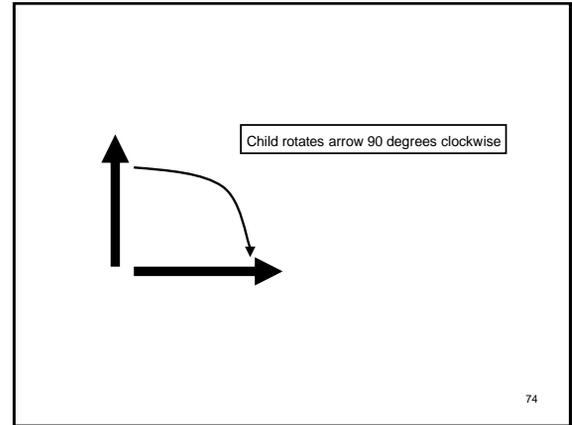
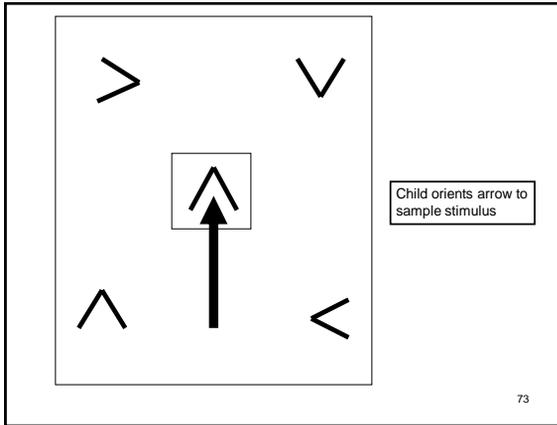
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- Children were dismal failures at the task under these conditions.
- So a joint source of control was added:
  - Subjects learned to orient an arrow to each stimulus in a characteristic way.
  - Then they were taught to rotate the arrow 90 degrees clockwise
  - Then they were taught to hold up the rotated arrow to each comparison.
  - Only one would match the leaned pattern.

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Causin, Albert, Carbone, & Sweeney-Kerwin  
(2013)

- Subjects: Three children with autism, 6-14 yrs. old, two vocal-verbal, one non-vocal.
- Task: From a disorderly array of 12 pictures, "Give me A, B, and C" (eg., "shoes, car, and grapes") *in that order*.

(Note the analogy with "Find 3914061")

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- Subjects were taught to rehearse the request, either vocally or with hand-signs, throughout the task.
- Results: All children mastered the trained tasks and were able to generalize to many novel examples without training. That is, they learned the strategy of rehearsing to mediate correct selection.
- Performance was correlated with rehearsals, (even when incorrect).
- Extra practice with rehearsals improved performance directly.

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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"

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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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## Gutierrez

Replicated and extended by DeGraaf & Schlinger, 2012

- **Subjects:**
  - Typically-developed college students
- **Task:**
  - Learn a set of spoken tacts of written Mandarin characters.
  - Given a spoken sequence of four characters, arrange the written characters in that order, from left to right.
  - Rehearsal prevented by distractor task.

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- **Results:**
  - Prevention of rehearsal ruined performance.
  - Partial exception in the case of one subject who engaged in the distractor task very slowly.
- **Conclusion:**
  - Correct responding was under joint self-echoic/tact control.

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## Wright (2006)

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## Part II: Theoretical considerations

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## Some “logical functions” of joint control

- Same type as X
- Identical to X
- Bigger than X
- Left of X
- Before X
- Under X
- Square root of X
- (Equivalence, naming, and relational frames)
- In every case we identify the correct answer by exploiting joint control (in a multiple-choice context).

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- 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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Which one is "the same type"?



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- The complexity of the performance becomes apparent when the discrimination becomes difficult.

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## Identity

Are they identical?

A

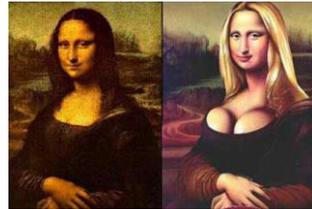
A

98

Are they identical?



99



Are they identical?

100

Symbolic matching to sample



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Comparisons



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Thus identity, type, relative size, etc. is not “in the stimuli.” It’s in our responses to stimuli.

The discrimination of the onset of joint control can apply to all examples, regardless of the novelty of the examples.

Thus joint control solves an otherwise mysterious property of behavior.

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## The “subjective reality” of the phenomenon is beyond doubt.

- In the grade school that I attended as a child, a single teacher taught two grades in the same room. While one class recited, the other worked on its assignments. One day in third grade, when the teacher was talking with the other class, I raised my hand, waved it wildly to attract her attention, and said, “I was *reading* the word ‘middle’ just when you *said* it.” (Skinner, 1978, p. 171)

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- But note that there was no self-echoic in this example. Lowenkron’s definition is too narrow:

“Joint control occurs when the currently rehearsed topography of a verbal operant, as evoked by one stimulus, is simultaneously evoked by another stimulus.”

So defined, joint control is just the most experimentally tractable end of a range of important related phenomena.

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## (1) Proposed revision

- When the second of two discriminative stimuli that control a given response form is introduced, response strength jumps.
- This jump has stimulus properties that generalize from one example to the next. It can be a discriminable event that controls subsequent behavior.
  - (That is, we notice it, just as Skinner did as a 3<sup>rd</sup> grader.)

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(2) The jump in response strength can be discriminable even if the response under one source of control is too weak to be emitted. (!!!)

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## 3<sup>rd</sup> Skinner anecdote

- “I once forgot to turn off an electric soldering iron which I had been using in a basement workshop. Thirty-four hours later I read the word *solder*, immediately jumped up, went to the basement, and turned the iron off. Here a latent response of inadequate but nevertheless considerable strength had persisted for many hours. The textual response to the printed word was a necessary supplement in “remembering the iron.” (1948, p. 88)

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- In this example he was not rehearsing “solder...solder...solder”. But the effect of reading the word had a dramatic effect that it certainly would not have had if he had not recently been using the soldering iron. That is, the response “solder” was at partial strength, but clearly too weak to be emitted on its own.

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## An experimental demonstration: The “Disraeli effect”

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- When my daughter was a kid, she, like most American children, at one time had learned the names of the capitals of all the states, but I thought it unlikely that all of them were currently strong in her repertoire.
- “What is the capital of North Dakota?” I asked.
- “Um ... Hmm...” she mumbled.

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- “Never mind. Forget it ... Now I’m going to list some famous 19th-century Europeans.... Here we go: Napoleon..., Tallyrand..., William Gladstone..., Benjamin Disraeli..., Otto von Bismarck..., Gordon ...”
- “Bismarck!” she cried.

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- It is evident that *Bismarck* was uttered in strength not because it was a mere echoic to a name—she did not echo *Disraeli* or *Tallyrand*—but because it satisfied the previous contingency. But since the question alone did not evoke the target response, it is equally clear that both sources of control were necessary. That is, the response was under joint control.

113

- One source of control was the spoken word *Bismarck*, but it is evident that the second source of control could not be a covert self-echoic, for (as in the Skinner anecdote) she had not yet emitted it in any form.
- Moreover, it isn’t clear what the second source of control was.

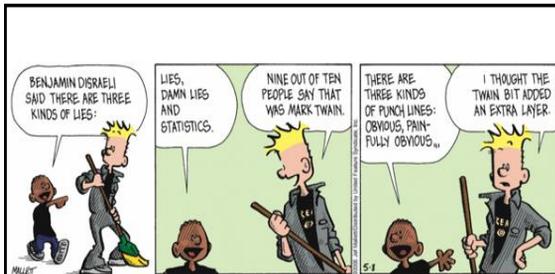
114

- When the word *Bismarck* was presented as an auditory stimulus, it potentiated a response form that was already strong. The discrepant jump in response strength was a salient event that identified the response as “the answer”. On this account, joint control does not necessarily require the simultaneous presentation of discriminative stimuli.

115

## Why do I call this the “Disraeli effect”?

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“On Tuesday evening, reminiscing about our graduate student years, Eddie Newman and I tried to recall Dave Wheeler’s name and failed. Later, possibly the next morning, I got it. I planned to tell Eddie when I saw him. Just now, about 40 hours later, I caught a glimpse of WHEELER in the program of a meeting and instantly recalled our effort. The fact that I had recalled the name did not cancel the heightened condition of my textual response.

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- These anecdotes suggest that response strength is not all-or-none.
- Latent behavior can fluctuate in strength.
- That is, a stimulus can evoke a response in partial strength, but not strong enough to be emitted.

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- How long do the evocative effects of a salient event last? How long will *Bismarck* tend to contribute to joint control?
- That is, how long can a latent response remain in a state of strength?
- It’s an experimental question, but surely there is no unitary answer.
- If salient events tend to be conditioned, their effects might be prolonged as long as stimulus control endures. That is, the present context can evoke a relevant response at strength indefinitely.
- If so, an event that evokes a strong discriminated response (i.e., “memory”) of the same form might do so with special strength. We would tact it so.

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### (3) Why is joint control discriminable?

- Ordinarily the effect of a saccade, or of a sequence of auditory stimuli, is to produce competing evocative effects. That is the norm, against which a supplementary effect is conspicuous.

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### Skinner: Concept of descriptive autoclitic

- Suggests that response strength is discriminable:
  - I hesitate to say...
  - I am certain that...
  - I think...
  - I am inclined to assert...

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### (4) Joint control in automatic reinf.

- Consider the case of the child who sets out for the first time to play a familiar tune on an unfamiliar instrument, say, a xylophone. When the child hits the correct keys, his "listener behavior" is jointly controlled by the resulting auditory stimulus as well as the covert (or perhaps overt) behavior of singing along.
- When the correct key is hit, behavior is under joint control; when the wrong key is hit, joint control ceases abruptly.
- Thus joint control as a discriminable event may be the conditioned reinforcer putatively underlying imitation, generalized imitation, and all conformity to patterns established by a social community.
- To put it loosely, we "recognize" that we have matched when joint control occurs; we cry, "That's it!" The establishment of joint control as a conditioned reinforcer in such contexts doubtless occurs very early for children and is presumably conditional upon other variables. (Sometimes conformity is reinforced and sometimes it is not.)

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- Applies also to generalized imitation:
  - How does the child know he has imitated?
  - His response to his own behavior "matches" that of the model.

124

### Additivity of response strength in problem solving: Find $\sqrt{1764}$

- "Square root of 1764. . .
- 100 times 100 . . . too big
- 50 times 50 . . . 2500 Too big
- 40 times 40 . . . too small
- Between 40 and 50
- 1764 . . . it's closer to 40
- 40-something
- It ends in 4
- 8 times 8 ends in 4; could be 48
- 2 times 2 is 4; could be 42
- Can't be 43
- 42 or 48 . . . closer to 40
- Must be 42"
- "40-something" plus "42 or 48" plus "close to 40" all add strength to 42 and nothing else.

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- 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.

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