

Conversation II: The Role of Prosody in the Stimulus Control of Verbal Behavior

- Prosody is the song of speech, and its role in verbal behavior is underestimated.
- Two topics:
 - Physical properties
 - Functions
- Autistic children often (but not always) have atypical prosody, and it may impair their ability to understand and engage in novel, complex verbal behavior characteristic of many conversations.

Physical properties: Note Heterogeneity

- Pitch (frequency)
 - Baseline
 - Species-specific: low end of auditory range
 - Hearing range = approx. 20Hz – 20,000Hz
 - Middle C = ~250 Hz; High C = ~1000 Hz
 - Babies' cries: 450-600Hz, 2000Hz possible
 - Gender
 - Age
 - Condition
 - Elicited changes
 - Operant changes
 - Singing
 - Verbal functions
 - Fluctuations in pitch within verbal units

Intensity (loudness)

- Baseline: not relevant
- Elicited changes
- Operant changes
 - Contingency-driven
 - Whispers to shouts
 - Once acquired, can recede to subvocal, even neural level.
 - Stress in speech is a matter of differential intensity

Rate

- Range limited by physiology of vocal apparatus.
- Range limited by discriminability to the listener, hence contingency-shaped.

Cadence

- Patterns of fluctuations in rate, stress, pitch, and pausing. That which makes poetry poetic.
- Baseline:
 - Rhythm in babbling?
 - Ululation in keening?
- Operant
 - A great variety of acquired patterns

Physical properties (cont'd.)

Diaphragm controls the rate and force of inspiration and expiration;

Larynx controls pitch;

Lips and tongue control pausing, stoppage, and build-up of pressure.

Note that these are the same structures that produce phonemes and morphemes.

Multiple other functions of structures: respiration, eating, biting, tasting, sneezing, emotional expression

Expiration typically coincides with the extended verbal unit conventionally called "the sentence."

Thus the vocal apparatus engages in astonishingly complex patterns of behavior serving prosodic, articulatory and semantic functions simultaneously, to say nothing of non-verbal functions. Consequently, stimulus control must be shifting with lightning speed from moment to moment as we speak.

Prosody serves several functions.

1) Affect is betrayed by intonation

- Differential rate, pitch, intensity
 - Elicited (cries, alarm, anger, anguish)
 - Operant (typically under audience control)

*Thank you for sending me your portfolio of 35 papers on river bottom sediments, Mr. Whittlesby.

*Stop in any time, and feel free to bring your bull mastiff again.

*Did you REALLY tell him you were NORWEGIAN??

(The intonation may be independent of content. Moreover, it may not even be verbal, in Skinner's sense, at all. That is, it might not depend upon the listener but might be a side effect of the emotional state of the speaker, but commonly our intonation serves an important communicative function [autoclitic, in Skinner's terms].)

2. Prosody differentiates verbal operants otherwise identical:

- con¹- duct vs. con – duct'
- ab¹- stract vs. ab - stract'
- ad¹ – dress vs. ad – dress'
- en¹ – trance vs. en – trance'
- Here the prosody is a property of the response itself; it is part of the response topography, not a second response.

3. Prosody provides autoclitic contrast

The **doctor** ordered you to stop eating anchovies.
 The doctor **ordered** you to stop eating anchovies.
 The doctor ordered **you** to stop eating anchovies.
 The doctor ordered you to **stop** eating anchovies.
 The doctor ordered you to stop **eating** anchovies.
 The doctor ordered you to stop eating **anchovies**.

(What is the status of this intonation? Is it a response property or is it an operant in its own right? I would argue that it is a separate operant. The effect of intonation is to emphasize a term in contrast to the listener's tendency to say something different. Thus it is an autoclitic, modifying the listener's behavior with respect to other verbal behavior.)

4. Intonation alters the function of an utterance:

Hal drove to Boston?

Hal drove to Boston.

Again, the intonation is autoclitic, modifying the response of the listener to an utterance. (Function varies across verbal communities; e.g., Mandarin)

5. Prosody marks the boundaries of verbal operants.

- "green house" vs. "greenhouse"
- "I bought cream cheese and crackers" vs. "I bought cream, cheese, and crackers."
- Declarative sentences end in distinctive prosodic "downturns;" interrogatives in "upturns."
- Clauses are marked with distinctive boundary pauses.

6. Prosody as reinforcer

("Speak like rain!")

- In newborns
- Song
- Poetry
- Humor

(Note complexity of concurrent control)

- Emphasis here on a seventh role of prosody in verbal behavior:

Prosody as a variable in controlling transitions in the speaker's ongoing verbal behavior.

- If I am correct, this is by far the most important function of prosody.

A salutary exercise

- How would you design a robot, a machine, or an organism that can behave as humans do? (You can assume omnipotence.)
- Machines or robots act as they do because of current conditions (internal and external).
- The role of history in behavior is to alter the probability of behavior with respect to those "current" conditions; that is those conditions that obtain when the behavior occurs.

Designing a Verbal Machine

For him who would design a verbal robot, facts, mands, echoics, textuials, and intraverbals pose relatively little problem.

But sentence frames are a nightmare!

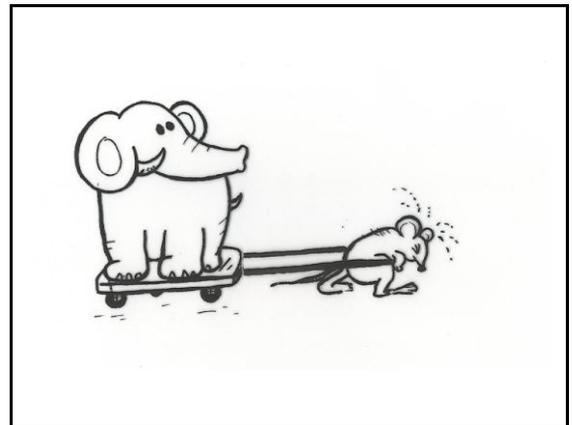
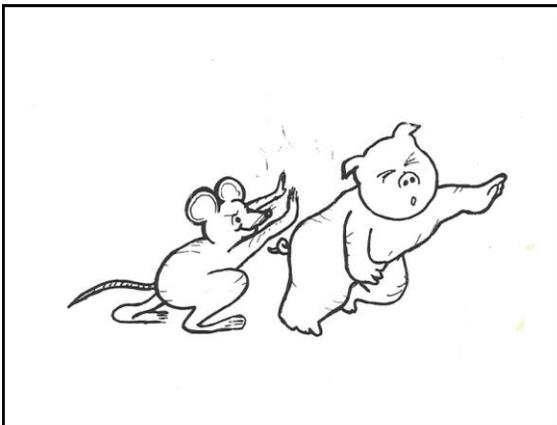
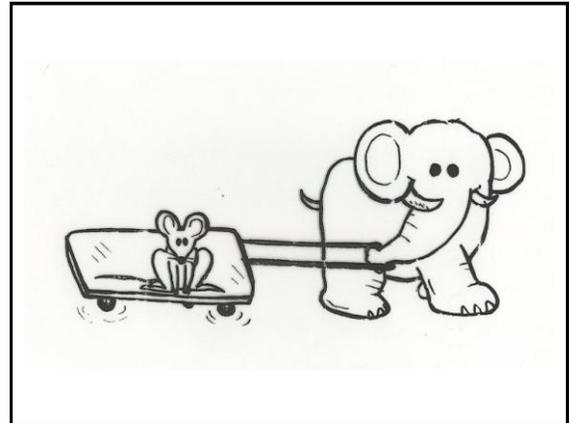
Why?

Because sentence frames require abrupt shifts in stimulus control between terms that have never occurred together before.

The sentence Frame

- An operant consisting of a set of variable terms that are embedded in a set of fixed responses, intraverbally related.
- sentence frames lie at the heart of what is traditionally called "grammar."
- Example: The passive voice:
The X is being Y-ed by the Z.
 - The horse is being washed by the groom.
 - The bride is being kissed by the groom.
 - The speech is being delivered by the orator.
 - The room is being cleaned by the maid.

- Repeated exposure to the frame leads to acquisition of the frame and application to novel cases.
- The mystery is how the variable terms are interwoven with the constants.
- Consider the following experiment in which children acquired the passive construction through modeling:



- Clearly the utterance is an interweaving of an sentence frame (the X is being Y-ed by the Z) and tacts under control of the picture.

- But this requires the rapid shift in stimulus control, as we speak, between the picture and the intraverbal frame.
- What are the necessary and sufficient properties of X to occasion the shift in stimulus control from the picture to the frame? (Eg, in "The elephant is being pulled by the mouse," what controls saying "is being"?)
- We can't appeal to a history in which "is being" followed "the elephant".

- The context is multifaceted; a lot of operants are strong concurrently: Mouse, elephant, cart, effort, "the X is being Y-ed by the Z, pulling, picture, etc., but verbal behavior is not a random jumble of such utterances; it is smoothly ordered.
- That is to say, "is being" occurred at the right time and place; we don't say "is being the elephant pulled by the mouse" or "the elephant pulled is being by the mouse." Somehow "is being" is controlled at least in part, by a novel stimulus (the utterance, "the elephant"), The mystery is how it can be so controlled.
- Don't be fooled by how effortless it is for you. Think of the robot.

A simpler case: To "mull something over"

- Example
 - Ernie floated the proposal that we take a taxi to the restaurant in Cambridge and return by foot to the house. We mulled it over.
- The frame is "mull X over."
- The question is, what are the necessary and sufficient properties of X to shift control to "over." That is, what are the controlling variables for saying "over" at the moment that we do?"

- Appealing to a simple history of reinforcement is inadequate. Perhaps "mull it over" has occurred in our history in the past and has been reinforced. But that account doesn't hold for novel cases. Consider the following hypothetical exchange:

- Ernie floated the proposal that we take a taxi to the restaurant in Cambridge and return by foot to the house. We mulled it over.*
- What? What was it you did?
- We mulled the proposal over.*
- Sorry, for being so stupid, but I wasn't paying attention. What proposal?
- We mulled the proposal that we take a taxi to the restaurant in Cambridge over.*
- Whose proposal?
- We mulled the proposal that Ernie made that we take a taxi to the restaurant in Cambridge and return by foot to the house over.*

- Grammatically speaking, X is
 - 1) a noun phrase, or
 - 2) a noun phrase followed by a relative clause, or
 - 3) a noun phrase followed by a potentially unlimited set of recursive relative clauses.
 Clearly X does not have any constant phonemic properties that can serve as a controlling variable for “over.”

- This is a general problem for all sentence frames. Because they embed variable terms (X, Y, etc.), there are no phonemic constants to control transitions in the verbal string.
- Analogy of the buffet table

But the absence of phonemic constants doesn't mean there are no constants.

- 1) Variable terms take time.
- 2) Variable terms consist of vocalizations.

So why don't we say “we mulled the over” rather than “we mulled the proposal over”?

3) Variable terms have distinctive prosody.

- Note where the stress falls:
 - The horse is being washed by the groom.
 - The bride is being kissed by the groom.
 - The speech is being delivered by the orator.
 - The room is being cleaned by the maid.
 - The X is being Y-ed by the Z.
- Here the prosodic contour is constant from example to example and is therefore a plausible candidate for one variable controlling transitions in the sentence frame.

- “the proposal” has an emphasis that “the” alone does not, hence

We mulled the proposal over
but not
We mulled the over.

- Relative clauses are parenthetical intrusions into sentence frames. They are strongly marked by prosodic cues.
- *We mulled the proposal that Ernie made that we take a taxi to the restaurant in Cambridge and return by foot to the house over.*
- Notice how weak “over” is in this example. There is nothing grammatically anomalous here, but the temporal and prosodic features are so atypical that the intraverbal control by “mulled” has been almost entirely vitiated.

Another example from a 3-yr-old

- Say X again.
- Say Jack and Jill again.
- Say "Humpty Dumpty sat on a wall, Humpty Dumpty had a great fall, All the King's horses and all the King's men, Couldn't put Humpty together again" again.

- Once again, the variable term is extraordinarily long, and control of the final “again” has been correspondingly weakened. However, the variable has a distinctive prosodic downturn at the end, a downturn that may serve as the critical controlling variable.

- The stimulus control of verbal behavior is exquisitely subtle, and it is a formidable problem to identify the invariants that control transition in verbal strings. However the term prosody embraces a family of properties of verbal behavior that is commonly overlooked. It is a tenable hypothesis that prosody provides some of the missing invariants.
- My thesis is that in the last cases being considered, prosody is an important controlling variable for the speaker. Prosody helps the speaker order verbal operants in systematic ways.

Conclusion

- I'm suggesting that variable terms, in the language of traditional grammar, the “nouns” and “relative clauses” and other grammatical concepts, have distinctive prosodic features that help guide the speaker's own verbal behavior.
- Prosody then is an essential feature of certain verbal operants. It is not a trivial curiosity.
- Prediction: If appropriate prosodic behavior has not been acquired, speakers will be unable to interweave variable terms and sentence frames. (Or at least, the interweaving will be abnormal.)

Points for Discussion

- 1) If this analysis is valid, what are the implications for autistic kids, among whom prosody is often quite atypical?
 - Can it be acquired like other dimensions of verbal behavior through direct training?
 - Can it be acquired through modeling in the absence of explicit instruction?
 - If so, might it not be a kind of “behavioral cusp” that would give rise to more sophisticated verbal constructions in that population?
- 2) Echolalia, complete with great prosodic fidelity, is common among autistic kids.
 - Why then do they have trouble with prosody?
 - Do echolalics acquire more sophisticated verbal constructions than autistic kids who have impaired sensitivity to prosody?