Generative Verbal Learning and Children with Autism

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Typically developing children begin to demonstrate an explosion of language as early as 18 months (e.g., Hart & Risley, 1995; Rosales-Ruiz & Baer, 1997).

New and more complex speaker and listener skills emerge without direct training or direct reinforcement.

Many children with autism don’t make this verbal leap.

**Generative learning**: Acquiring one skill that enables or accelerates the acquisition of other skills, without direct training or reinforcement.

For example, learning to walk allows a child access to new stimuli, motivators, reinforcers, and punishers that shape new behaviors.
Generative Learning

- How do we establish generative learning for those who fail to acquire it in the conventional manner?
- What are the processes for typically developing children?
- Three types of generalization: stimulus generalization, response generalization, and generative learning (Alessi, 1987; Stewart, McElwee, & Ming, 2013)
- There are many behavioral contributions to the study of generative learning
Behavioral Contributions to Research on Generative Learning

- Verbal behavior (Skinner, 1957)
- Equivalence (Sidman, 1971)
- Cumulative-hierarchical learning (Staats, 1975)
- Observational learning (Bandura, 1977)
- General case (Becker, 1978)
- Direct instruction (Englemann & Carnine, 1982)
- Recombinative generalization (Goldstein, 1983)
- Joint control (Lowenkron, 1984)
- Pivotal response (Koegel & Koegel, 1988)
- Precision teaching (Lindsley, 1992)
• Morningside model of generative instruction (Johnson & Layng, 1994)
• Naming (Horne & Lowe, 1996)
• Behavioral cusps (Rosales-Ruiz & Baer, 1997)
• Derived relational responding (Hayes, Barnes-Holmes, & Roche, 2001)
• Behavioral productivity (Malott, 2003)
• Higher-order verbal operants (Catania, 2007)
• Verbal capabilities (Greer & Ross, 2008)
• I hope to connect the dots between these theories and autism
Rosales-Ruiz & Baer define a behavioral cusp as: “any behavior change that brings the organism’s behavior into contact with new contingencies that have even more far-reaching consequences” (p. 533)

“What makes a behavior change a cusp is that it exposes the individual’s repertoire to new reinforcers and punishers, new stimulus controls, new communities of maintaining or destructive contingencies...

....When some or all of those events happen the individual’s repertoire expands...

...and perhaps that leads to some further cusps” (p. 534)
Early Generative Learning and Behavioral Cusps

- Motor behavior cusps (e.g., a pincer grasp, walking) (Lucas video)
- Social behavior cusps (e.g., joint attention, adults as S in)
- Early language acquisition cusps (e.g., mand, listener, imitation, echoic, automatic reinforcement)
- Negative behaviors can be generative cusps as well (e.g., tantrums, mands for help rather than problem solving, learning to lie)
Behavioral Cusps

- A cusp represents a new level of learning for a child
- The difference between the acquisition of a cusp and the facilitative effects of a cusp
- A cusp can facilitate subsequent learning by being a prerequisite or a component of more complex behavior
- Not all cusps are equal, some are especially generative
- The combination of certain cusps can have far-reaching generative effects (e.g., echoic, tact, listener, self-listener)
- For more details on cusps see: Bosch & Fuqua, 2001; Hixson, 2004; Hixson, Reynolds, Bradley-Johnson, & Johnson, 2010
One of Chomsky’s (1959) main concerns about Skinner (1957) was how can a child understand a sentence that she has never heard before; and how can she say a meaningful sentence that she has never said or heard before—without reinforcement?

Chomsky identified this effect as “linguistic productivity”

Malott (2003) suggested that Chomsky’s linguistic productivity “means responding appropriately in novel circumstances, where the stimuli may be novel or the appropriate response may be novel”
How do Novel Verbal Relations Emerge Without Direct Reinforcement?

- There are four similar, but distinct, behavioral accounts of how generative (novel, emergent, derived) verbal relations occur
- Equivalence (Sidman, 1994)
- Relational framing (Hayes et al., 2001)
- Bidirectional naming (Horne & Lowe, 1996)
- Joint control (Lowenkron, 1998)
Stimulus Equivalence, Common Bidirectional Naming, a Relational Frame of Coordination, and Verbal Behavior

A

- Directly taught
- Emergent relation

Symmetry
C-BiN
Mutual Entailment

Teach A-B
Listener

MTS/
Listener

MTS/
Tact

Teach A-C
Listener

Teach A-C
Textual

Symmetry
C-BiN
Mutual Entailment

Written
“cat”

B

Mutual Entailment
Symmetry

C-BiN

Written
“cat”

C

Transitivity
Transfer of function
Combinatorial Entailment
Class Expansion and Transfer of Function

- Directly taught
- Emergent relation

Diagram:

A: Auditory “cat”
B: Written “cat”
C: Listener
D: Sign “cat”

- Teach A-B
- Teach A-C

Intra-verbal
MTS/
Listener
MTS/
Tact

- Tact
- Listener
Class Merger and Categorization
Bidirectional Naming (BiN) (Horne & Lowe, 1996)

- Common BiN (C-BiN): the acquisition of a tact relation immediately produces a corresponding listener relation, and the acquisition of a listener relation immediately produces a corresponding tact relation, without direct training or reinforcement.
- C-BiN initially establishes a child’s interlocking speaker (tact) and listener discrimination (LD) repertoires.
- C-BiN involves the combination of five verbal cusps: echoic, self-echoic, listener, self-listener, and tact (Greer & Ross, 2008; Horne & Lowe, 1996; Miguel, 2018).
Bidirectional Naming (BiN)  
(Horne & Lowe, 1996)

- Intraverbal BiN (I-BiN): a bidirectional relation between words (e.g., training on “cat” and “animal” generates a reverse intraverbal without training—“animal” and “cat”)
- Visual-BiN (V-BiN): a bidirectional relation between visual stimuli (e.g., training on matching a written word to a picture generates the ability to match the picture to the written word)
- BiNs (especially when combined) can produce stimulus equivalence, relational frames, and emergent relations (e.g., Diaz, Luoma, & Miguel, 2019; Horne & Lowe, 1996; Jennings & Miguel, 2017; Ma, Miguel, & Jennings, 2016; Perez-Gonzalez, Salamah, & Garcia-Asenjo, 2018)
How C-BiN Produces Listener to Tact Emergence

Divergent multiple control: Evocative and function-altering
Convergent multiple control: Conditional discrimination

Auditory $S^D$

“Where’s the cat?”

V-$S^D_1$ NV-$S^D_1$

V-$S^D_2$

V-$S^D_3$

V-R$_1$ Orient NV-R$_1$

Echoic “cat” NV-$S^D_1$

NV-R$_2$ Points to cat NV-$S^D_1$

Self-echoic “cat”

V-R2 Self-listener

Social $S^r$

Automatic $S^r$
Incidental Learning

- Acquiring new behaviors or whole repertoires through the observation of others emitting responses and obtaining reinforcement, or observation of others receiving instruction, correction, and reinforcement (Bandura, 1975; Greer & Ross, 2008; Hart & Risley, 1975)
Incidental Tact and Listener Learning Through C-BiN and Joint Control

Observational experience

Peer audience

Peer says “Teeter totter”

MO

Ellen

Overt or covert tact trial

NV-R₁ Orient

NV-Sᴰ₁

V-Sᴰ₁

V-SDL₁

V-SDL₂

MO

NV-Sᴰ₂

V-R₁ Echoic “teeter totter”

Self-audience

Self-listener

NV-Sᴰ₃

NV-Sᴰ₄

Joint control

Automatic Sr

Listener trial with joint control

NV-R₂ Orient

Automatic Sr
Incidental Intraverbal Learning Through C-BiN and I-BiN

Observational Experience #2

Peer #2 audience

“Play-ground”

MO

Ellen

NV-R_{1} Orient

V-R_{1} Echoic “play ground”

Self-audience

Overt or covert tact trial

Listener trial with joint control

NV-R_{2} Orient

V-R_{2} Self-echoic “play-ground”

Self-listener

Automatic Sr

Automatic Sr

Incidental Intraverbal Learning Through C-BiN and I-BiN

Ellen

Observational Experience #2

Peer #2 audience

“Play-ground”

MO

NV-S_{D_{1}}^D

NV-S_{D_{2}}^D

V-S_{D_{1}}^D

V-S_{D_{2}}^D

V-S_{D_{3}}^D

NV-S_{D_{4}}^D

NV-S_{D_{4}}^D

Automatic Sr

Automatic Sr
Incidental Intraverbal Learning Through C-BiN and I-BiN

✿ Future condition

✿ Parent audience

✿ "What did you do at the playground?"

✿ Second context

✿ "teeter totter"

✿ "Ellen"

✿ Emergent/Derived Intraverbal Relation

✿ Social S^r

✿ NV-S^D_1

✿ NV-S^D_2

✿ V-S^D
Incidental Emergence of Equivalence and a Relational Frame Through C-BiN and I-BiN
Class Expansion and Transformation of Function Through C-BiN and I-BiN

D

“Dangerous”

Tact

Intraverbal

A

“Teeter-totter”

Tact

Intraverbal

B

Auditory playground”

Tact

Intraverbal

C

Listener

Listener

Listener

Listener
Establishing Generative Language Learning for Children with Autism

- First, build the verbal operants, listener skills, and MTS to cusp status
- Establish self-VB (speaker and listener in the same skin) (e.g., say-do correspondence, think-do, think-say, self-talk during imaginative play)
- Intersperse tact, listener, echoic, self-echoic, and MTS training trials in varied contexts (“mixed VB;” Sundberg & Partington, 1998)
- Establish BiN repertoires with MEI (Greer & Ross, 2008)
- Establish joint control repertoires (Lowenkron, 1998)
- Use incidental teaching procedures (Greer & Ross, 2008; Hart & Risley, 1975)
- Establish equivalent (Sidman, 1971) and nonequivalent relations (Hayes, et. al, 2001)
Conclusions

- Generative learning is the driving force of language acquisition
- The end result of generative learning is the self-produced advancement of one’s own verbal repertoire
- C-BiN, I-BiN, V-BiN, and joint control provide a molecular treatment of the processes involved in many types of generative learning
- Next, I will describe how to use the VB-MAPP to identify a child’s generative learning capabilities across all of the domains
Using the VB-MAPP to Identify and Develop Generative Learning Repertoires

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The benefits of behavioral cusps and generative learning for children with autism

The VB-MAPP is an assessment tool that provides a measure of 170 linguistic milestones occurring in early language development

Many of the milestones on the VB-MAPP can be classified as cusps or generative cusps and can be used to provide a measure of a child’s generative learning skills
VB-MAPP Level 1 Profile

VB-MAPP
Master Scoring Form

Name: Carroll
Date of birth: 1/4/2
Age at testing: 1 1/2

Key: Score Date Color Tester
1st test: 17
2nd test:
3rd test:
4th test:

LEVEL 3

Date of birth:
Age at testing:
Date Color Tester
Child's name: 1st test:

LEVEL 2

LEVEL 1

Child's name:
VB-MAPP Level 1: Generative Cusps
**Mand 5.** Emits 10 different mands without prompts (except, *What do you want?*) — the desired item can be present (e.g., *apple, swing, car, juice*)

**Social 5.** Spontaneously follows peers or imitates their motor behavior 2 times (e.g., follows a peer into a playhouse)

**Vocal 5.** Spontaneously vocalizes 15 whole words or phrases with appropriate intonation and rhythm
VB-MAPP Level 1: Generative Cusps
The Road to Generative Learning: Developing Early Behavioral Cusps

• What are the language and social skills demonstrated by a typically developing 18 month old child?
• “18-month-old twins Stella and Lilah hold a short meeting in a laundry basket to discuss socks” (video babies in a basket)
• Speaker skills (expressive language)
  • Mand
  • Echoic
  • Motor imitation
  • Tact
The Road to Generative Learning: Developing Early Behavioral Cusps

- Listener skills (comprehension)
  - Respond nonverbally to words: Listener discriminations (“receptive language”)
  - Respond verbally to words (emit echoic, mand, tact, and intraverbal responses)
- Visual perceptual skills
  - Matching, sorting, eye-hand coordination, etc.
- Play
  - Independent play
  - Social play
- Social interaction (speaker-listener exchanges, turn taking, sharing)
VB-MAPP Level 1: Generative (G) and Developing Cusps (DC)
• Basic speaker, listener, social, and perceptual repertoires become established
• These basic behavioral repertoires provide the prerequisite and component repertoires necessary to produce generative learning
• The combination of cusps produces especially powerful generative effects (e.g., C-BiN, I-BiN, equivalence, relational frames, joint control, recombinative generalization, incidental learning)
VB-MAPP Level 2: Generative (G) and Developing Cusps (DC)
• **Tact 9.** Tacts 50 two-component verb-noun and/or noun-verb combinations, tested or from a list of known two-component tacts (e.g., *washing face, Joe swinging, baby sleeping*).

• **Listener 9.** Follows 50 two-component noun-verb and/or verb-noun instructions (e.g., *Show me the baby sleeping. Push the swing.*).

• **Linguistics 9.** Emits functional prosody (i.e., rhythm, stress, intonation) on 5 occasions in one day (e.g., puts emphasis or stress on certain words such as, *It’s MINE!*).

• **Mand 10.** Emits 10 new mands without specific mand training (e.g., spontaneously says *Where kitty go?*)
VB-MAPP Level 2
Generative Learning Repertoires

- **Tact 10.** Tacts a total of 200 nouns and/or verbs (or other parts of speech), tested or from an accumulated list of known tacts
- **Listener 10.** Selects the correct item in a book, picture scene, or natural environment when named for 250 items, tested or from an accumulated list of known words
- **VP/MTS 10.** Matches non-identical objects (3D) to pictures (2D) and/or vice versa, in a messy array of 10 containing 3 similar stimuli, for 25 items
- **Play 10.** Assembles toys that have multiple parts for 5 different sets of materials (e.g., Mr. Potato Head, Little People sets, Cooties bugs, Kid K’ Nex)
• **Social 10.** Spontaneously mands to peers to participate in games, social play, etc., 2 times (e.g., *Come on you guys. Let’s dig a hole.*)

• **Echoic 10.** Scores at least 90 on the EESA subtest (at least 10 from Groups 4 and 5)

• **Motor Imitation 10.** Imitates (or attempts to with approximations) any novel motor action modeled by an adult with and without objects (i.e., a “generalized imitative repertoire”)
• **LRFFC 10.** Spontaneously tacts the item on 50% of the LRFFC trials (e.g., says *dog* given the verbal statement, *Find an animal*, and a visual array containing a picture of a dog)
The tact brings the necessary elements of an intraverbal relation into the reinforced LRFFC trial, and a new IV relation gets reinforced along with the listener selection behavior.

Tacting in LRFFC brings the speaker and listener repertoires together.

“Variables Contributing to the Emergence of Intraverbal Responses after Listener Training” (Conine, Vollmer, & Dela Rosa, 2019)

The goal of their study was to determine whether tacts emitted during listener training predict emergent intraverbals.

Target intraverbals were probed (e.g., What flies? What swims?), then LRFFC training was provided, followed by another intraverbal probe, then tact training, and a final intraverbal probe.
The observed emergent intraverbal behavior is a function of 5 types of multiple control (behavioral cusps) that interact with each other and affect behavior simultaneously:

1) Auditory conditional discrimination
2) Divergent control: verbal $S^D$ evokes speaking, listening, & scanning
3) Joint control: Tact/ IV evokes “dog” which evokes selection behavior followed by reinforcement
4) C-BiN emergent tact-listener relations
5) I-BiN: emergent reverse intraverbal relations
• **Intraverbal 10.** Answers 25 different *who* or *where* questions (e.g., *Who is your friend? Where is your pillow?*)

• **Group 10.** Sits in a small group for 10 minutes, attends to the teacher or material for 50% of the period, and responds to 5 of a teacher’s SD's
VB-MAPP Level 3: Generative Cusps (G)
• **Mand 11.** Spontaneously mands for different verbal information using a WH question word 5 times (e.g., *What’s your name? Where do I go?*)

• **Tact 11.** Tacts the color, shape, and function of 5 objects (15 trials) when each object and question is presented in a mixed order (e.g., *What color is the refrigerator? What shape is the valentine? What do you do with the ball?*) (This is part tact and part intraverbal.)

• **Intraverbal 11.** Spontaneously emits 20 intraverbal comments (can be part mand) (e.g., Dad says, *I’m going to the car,* and the child spontaneously says, *I want to go for a ride!*)

**VB-MAPP Level 3 Generative Cusps**
Mand 12. Politely mands to stop an undesirable activity, or remove any aversive MO under 5 different circumstances (e.g., Please stop pushing me. No thank you. Excuse me, can you move?)

VP/MTS 12. Demonstrates generalized non-identical matching in a messy array of 10 with 3 similar stimuli, for 25 items (i.e., matches new items on the first trial)

Listener 13. Selects items from an array of similar stimuli based on 4 pairs of relative adjectives (e.g., big-little, long-short) and demonstrates actions based on 4 pairs of relative adverbs (e.g., quiet-loud, fast-slow)
• **LRFFC 14.** Selects the correct items from a book or the natural environment given 4 different rotating LRFFC questions about a single topic (*Where does the cow live? What does the cow eat? Who milks the cow?*) for 25 different topics

• **Group 14.** Acquires 2 new behaviors during a 15-minute group-teaching format involving 5 or more children

• **Play 15.** Independently draws or writes in pre-academic activity books for 5 minutes (e.g., dot-to-dot, matching games, mazes, tracing letters and numbers)
VB-MAPP Level 3 Generative Cusps

- **Social 15.** Engages in 4 verbal exchanges on 1 topic with peers for 5 topics (e.g., the children go back and forth talking about making a creek in a sandbox)
- **Writing 15.** Copies all 26 upper and lower case letters legibly
- **Intraverbal 15.** Answers 4 different rotating WH questions about a single topic for 10 topics (e.g., *Who takes you to school? Where do you go to school? What do you take to school?*)
• **Linguistics 15.** Combines noun and verb phrases to produce 10 different syntactically correct clauses or sentences containing at least 5 words (e.g., *The dog licked my face.*)

• **Math 15.** Correctly matches a written number to a quantity and a quantity to a written number for the numbers 1-5 (e.g., matches the number 3 to a picture of 3 trucks)
Complex intraverbal responses can emerge without direct training once 4 specific prerequisite speaker and listener skills are acquired (DeSouza, Fisher, & Rodriguez, 2019)

Establishing C-BiN and I-BiN can produce stimulus equivalence (e.g., Carp & Petursdottir, 2015; Horne & Lowe, 1996; Ma, Miguel, & Jennings, 2016; Perez-Gonzalez, Salameh, & Garcia-Asenjo, 2018)

Establishing C-BiN and I-BiN can produce relational frames of comparison (Diaz, Luoma, & Miguel, 2019)

Joint control shows how verbal behavior can mediate responding in MTS and RFT tasks (e.g., Clough, Meyer, & Miguel, 2016; DeGraaf & Schlinger, 2012; Sundberg, Sundberg, & Michael, 2018)
Conclusions

- Many types of cusps and generative learning are involved in typical language development.
- Skinner’s analysis of verbal behavior is a valuable tool for intervention programs attempting to establish cusps and generative learning.
- The combination of cusps and multiple control can produce especially powerful generative effects (e.g., naming, RFT, equivalence, joint control).
- The VB-MAPP provides a developmentally matched tool designed to measure a child’s generative learning repertoires.