Technologies Effective In Evoking First Instances of Speech In Large Cohorts of Non-Vocal Children With Autism

Smita Awasthi, Ph.D., BCBA-D
Behavior Momentum India

National Autism Conference Press Note Aug 6, 2019

Introduction

- NT kids acquire w/o direct training. (Harlaar, Hayiou-Thomas, Chile, & Plomin, 2006)
- Communication begins before speech emerges
- Children with ASD require highly specialized training to acquire speech, language and communication. (Harlaar et al., 2006; Rutter, 1995; Snowling)

Literature Review

- Stimulus Stimulus Pairing 
  Sundberg, et al. (1996)
- Rapid Motor Imitation & Mand Training 
  (Ross & Green,2003 & Tsiouri & Greer, 2003)
- Total Communication (Travers, 2004)
- Augmentative and Alternative Communication Strategies
  (Bondy & Frost, 1994; Carbone et al. 2010; Gervarter et al., 2015)
Echoic Training + Shaping

- Evoking vocals in non-vocal kids most challenging (Koegel, O’Dell, & Dunlap, 1988)
- Vocal imitation a pre-requisite for teaching other operants (Sundberg, 1990)
- 3 children trained to echo under mand conditions. However echoic repertoire pre-existing (Drash, High & Tudor, 1999)
- Examined through an assessment procedure the most effective echoic teaching procedure VIT, SSP & MM in 6 children (Cividini-Motta, Scharrer & Ahearn, 2016)

Rapid Motor Imitation & Mand Training

- Rapid motor imitation followed by a vocal model in 5 non-vocal children with ASD, 5.5-7.8 Y. Evoked vocals & mands (Ross & Greer, 2003)
- Replication with 2 participants. One was non-vocal. Emergence of first instances of echoics (mands and tacts). (Tsiouri & Greer, 2003)

Stimulus-Stimulus Pairing

- Stimulus Stimulus Pairing Sundberg, et al. (1996); Yoon and Bennet (2000); Miguel, et al. (2002); Esch, et al. (2005, 2009); Normand and Knoll (2006); Yoon and Feliciana (2007); Carroll and Klatt (2008); Stock et al., (2008); ); Esch et al., (2009); Petursdottir et al. (2011); Millotis et al., (2012); Rader et al., (2014); Shillingsberg et al. (2015); Petersdottir & Lepper (2015); Barry & Holloway (2019)
- Demonstrated increase in vocalizations
- Temporary effects
- Several variables studied


- Period: 1996-2014
  - 13 studies with 39 participants selected
  - 6 procedural variations
    a) Target Sound paired – novel / current
    b) No. Of experimenter- emitted sounds/pairing
    c) No. Of pairings/min
    d) Type of pairing,
    e) Adventitious reinforcement control,
    f) Type of preferred item paired,

- Conclusion: Moderate intervention effects
  Younger participants benefitted more
  Firm conclusions not possible - procedural variations.


- Period: 1967-2015
  - Identified behavioral/non-behavioral/mixed interventions
  - 63 behavioral intervention 968 participants
  - # SSP included in n=10 (14.5%) studies
  - 2 non behavioral intervention 52 participants
  - 7 mixed Interventions 193 participants

- Conclusion: a) Only behavioral interventions constituted EBP for speech deficits
  b) SSP & PECS were considered ineffective methods for promoting language acquisition
Introduction

Variance in the definition of vocal in the literature

- Being vocal but an inability to use functional speech – non-vocal
- Many studies had children with pre-existing vocals
- Vocal-verbal (Sundberg, 1996). Vocalizations that are speech related in contrast to non-speech vocalizations
- Verbal repertoire - based on number of vocalizations / and the number of functional response forms (Miguel et al. 2002)

Research Questions

Can the following methods lead to speech in non-vocal CWA?

a. Sign Mand training with vocal pairing?
b. Would the introduction of time-delay induce vocalization during sign mand training?
c. Would addition of intraverbal training as an independent variable be effective in inducing first vocals?
d. Finally does the introduction of sign-mand training and intraverbal training together as a treatment package be more effective in inducing vocalizations?

Response Topography Selection

- The role of augmentative and alternative communication (AAC) for non-vocal children with autism is considered emerging (NAC Panel 2009, 2015)
- AAC – unaided (signs) and aided (graphic symbols, communication boards and SGD’s)
- Manual signs – emerging (Wendt, 2009)
- Visual schedules – established (Mirenda & Brown, 2009)
- Successful outcomes for speech using AAC’s have little empirical evidence (Iacono et al, 2015)

Response Topography Selection

- Manual Sign Training
  (Bonvillian & Nelson, 1978; Carr, 1979; Carr & Kolajsinsky, 1983; Hurlbut, Iwata & Green, 1982; Sundberg, 1980, DiCarlo, Stricklin, Banaji, & Reid, 2001; Bartman & Freeman, 2003; Scattone & Bilhofer, 2008; Carbone et al., 2010)
- Picture Exchange Communication Systems
  (Bondy & Frost, 1993; Tincani, Crozier, & Alazetta, 2006; Canella-Malone, Fant, & Tullis 2010; Flipoerin, Reska & Watson, 2010; Greenberg, Tomino & Charlup, 2014)
- SGD’s
  Parsons & La Sorte, 1993; Lancioni, Reilly, Cuvo, Singh, Sigafoos & Didden, 2007; Schlosser et al., 2007; Olive et al., 2007)

Response Topography Selection

The current study preferred the use of Manual Sign Training

SGD’s could not be afforded in India by the centers

Making PECS Boards, training for different levels on PECS followed by staff training and ensuring TI – higher response effort

Intervention Centers & Staff

Participants were enrolled at one of 7 centers run by Behavior Momentum India

BCBA (2): staff training, supervision and monitoring, treatment integrity checks, IOA and data reviews.

Supervisors (17): min. 2 years hand-on experience. Involved in staff training, treatment integrity, IOA

Therapists (50): worked 1:1, conducted preference assessment, collected & transferred data and reported deviance / vocals
Method – (All Experiments)

Setting & Materials
- Clinic based 1:1 Setting
- 5 days/week (Mon – Fri)
- Class rooms
- Play park with
- Computer preloaded rhymes and movie songs

Participant Selection

Inclusion criteria:
- a) diagnosis of ASD
- b) being non-vocal

Non-vocal was defined as an inability to produce syllables, phonemes, sounds or words during assessments conducted under motivating operations.

Participant Selection

Exclusion criteria
- Having a disability other than autism
- The presence of any vocal phoneme, syllable, word approximation mand, tact, echoic, or intraverbal fill-in.
- Having speech but not under stimulus control, ability to sing rhymes but not talk or echo after model.

Participant Selection

Assessments
- Early Echoic Skills Assessment (EESA) – Group 1 included twenty-five simple and reduplicated syllables e.g. ‘ah’, ‘papa’ ‘moo’.
  Esch, 2008 (VB-MAPP).

Participant Selection

Current Study (2010-2016)
- Identified 144 non-vocal children with autism
- Excluded 18
- Total 126 children across 4 experiments
- Period: 6 years 8 months

Response Measurement

Baseline:
Assessment on vocal responses conducted on pre-selected Mands, Tacts, Echoics and Intraverbal fill-ins.

Intervention:
Daily first trial probes on target mands

After Each Vocal was Acquired as per Mastery Criteria:
Same as baseline
Mand Probes
- 30 minutes across 6 mands x 3 sessions
- Across table, in the play-park & computer with pre-loaded rhymes & songs
- Presented stimuli, offered play setting or contrived situation
- Access delayed by 3-5 seconds
- No verbal prompts were provided

Echoic Probe
- 5 sounds selected—aa, a, bu, ee & mmm
- The therapist sat across the child
- A vocal model “say ______” presented followed by a 3-sec pause
- 2 presentations for each sound in random order.
- No Sr+ was provided

Tact Probe
- The therapist sat across the child
- 5 pictures of common items selected
- Therapist asked “What is this?” followed by 3-5 sec pause
- 2 presentations made in random order for each.
- No Sr+

Intraverbal Probe
- Probes conducted at the table and natural environment
- 2 animal sounds, 2 rhymes & 2 fun fill-ins preselected
- Therapist initiated Cow says _____ / Twinkle l little _____ / Ready, steady ___ followed by a 3-5 second pause
- No vocal model or Sr+ provided

Inter Observer Agreement
Baseline: IOA on vocal status conducted on 100% trials on pre-selected mands, tacts, echoics and intraverbal
Results: 100% IOA on non-vocal status

Intervention: IOA on 5 probes on emerged vocals, followed by IOA across all operants as in Baseline
IOA = Total agreements x 100
Total Probes
Mean IOA of Study: 89% (Range 83% - 94%)

Treatment Integrity
50% intervention sessions observed by supervisor in 1st Week
Trainer Retraining on a score <80%
TI checks made one trial / target / month till end of intervention
M
Mean Treatment Integrity: 87% (57-100%)
ea

Data Taking
Yes / No Data collected
- Using clickers
- Vocal emergence transcribed in English / Hindi
- Every trial – Baseline
- Probe trials – Intervention
- After each vocal acquired
- Inter Observe Agreement
- Treatment Integrity Checks

Dependent Variable
Emergence of 7 topographically distinct vocals
- Emitted as a phoneme, word approximation or word
- Emitted independently or after a vocal model
- As (a)mand (b)echoic (c)echoic-mand (d)tact (e)intraverbal

Vocals:
Example: Saying bu, bis, biki for Biscuit
Non-examples: Saying any other syllable; fa, pa, moo
Excluded: crying, grunting, giggling or babbling
Experimental Design

- Non-concurrent, Delayed Multiple Baseline
- Each participant added to MBL as they became available once previous participant acquired minimum one vocal

Preference Assessment

A preference assessment was conducted prior to target selection for each participant

- 6 targets selected across settings i.e.
  - table top toys & edibles
  - Play park equipment's
  - Rhymes & songs on computer

Current Study

<table>
<thead>
<tr>
<th>Experiment</th>
<th>Participants</th>
<th>MBL</th>
<th>Independent Variable</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>58</td>
<td>13</td>
<td>Sign Mand Training + Paired Vocals</td>
</tr>
<tr>
<td>2</td>
<td>3</td>
<td>1</td>
<td>Sign Mand Training + Delayed Vocal Prompt</td>
</tr>
<tr>
<td>3</td>
<td>46</td>
<td>11</td>
<td>(1) Sign Mand Training (2) Added Intraverbal Trg</td>
</tr>
<tr>
<td>4</td>
<td>19</td>
<td>5</td>
<td>Sign Mand Training + Intraverbal Training</td>
</tr>
</tbody>
</table>

Experiment 1

Role of Sign Mand Training and Paired Vocals On The Emergence of Speech in 58 Non-Vocal Children With Autism

Experiment 1: MBL 1

Participants

5 Non-vocal participants with autism male
Age range 2.8 – 13.5 years
BLA score range 12 - 24/60
EESA score 0
Participants – Expt. 1 MBL 1

<table>
<thead>
<tr>
<th>Participant</th>
<th>Gender</th>
<th>Age</th>
<th>Diagnosis</th>
<th>BLA</th>
<th>EESA</th>
<th>H/O Intervention</th>
</tr>
</thead>
<tbody>
<tr>
<td>Biso</td>
<td>M</td>
<td>3.0</td>
<td>ASD</td>
<td>18/60</td>
<td>0</td>
<td>None</td>
</tr>
<tr>
<td>Amaz</td>
<td>M</td>
<td>2.8</td>
<td>ASD</td>
<td>14/60</td>
<td>0</td>
<td>None</td>
</tr>
<tr>
<td>Liv</td>
<td>M</td>
<td>2.10</td>
<td>ASD</td>
<td>12/60</td>
<td>0</td>
<td>None</td>
</tr>
<tr>
<td>Digun</td>
<td>M</td>
<td>3.8</td>
<td>ASD</td>
<td>25/60</td>
<td>0</td>
<td>Speech Therapy 8 mth</td>
</tr>
<tr>
<td>Dako</td>
<td>M</td>
<td>13.5</td>
<td>ASD</td>
<td>18/60</td>
<td>0</td>
<td>Speech Therapy &amp; OT 10 years intermittent</td>
</tr>
</tbody>
</table>

Preference Assessment

Table 1: List of Preferred Items

<table>
<thead>
<tr>
<th>Participant</th>
<th>Preferred Items</th>
</tr>
</thead>
<tbody>
<tr>
<td>Biso</td>
<td>Toys: Light ray, Musical ray, Bubbles, Book, Sponge Ball, Room, Pencil, Music</td>
</tr>
<tr>
<td>Amaz</td>
<td>Toys: Light ray, Musical ray, Pencil, Crayon, Pen, Book, Music &amp; Computer</td>
</tr>
<tr>
<td>Liv</td>
<td>Toys: Musical ray, Music on computer, Pen</td>
</tr>
<tr>
<td>Digun</td>
<td>Toys: Musical ray, Music on computer, Pen, Music</td>
</tr>
<tr>
<td>Dako</td>
<td>Toys: Musical ray, Music on computer, Pen</td>
</tr>
</tbody>
</table>

Intervention

- Sign-Mand training trials conducted with item in view
- Out of reach
- Each trial had 3 pairings
- 40 mand trials / day for all 6 targets

Mastery Criterion

For Vocalization: n=7 vocals across any operant.

For Each Vocal: Specific vocal on 1st trial for 5 consecutive sessions
IOA on 80% vocals

Vocals could be independent or repeated after the model during pairing. Participants who emerged with <n=7 vocals, or did not achieve mastery, continued on the intervention till the end of the study.
Figure 1.0: A multiple baseline across subjects to study the effect of manual sign mand training with paired vocals on inducing first instances of speech in nonverbal children with autism.

Vocal Emergence Videos

Results – Study 1

<table>
<thead>
<tr>
<th>Participant</th>
<th>Period of Intervention</th>
<th>Weeks to 1st Vocal</th>
<th>Weeks to 7th Vocal</th>
<th>Manual Signs Achieved Prior to Vocal</th>
</tr>
</thead>
<tbody>
<tr>
<td>Biso</td>
<td>5 weeks</td>
<td>2</td>
<td>5</td>
<td>6</td>
</tr>
<tr>
<td>Amaz</td>
<td>5 weeks</td>
<td>3</td>
<td>5</td>
<td>none</td>
</tr>
<tr>
<td>Liv</td>
<td>48 weeks</td>
<td>None</td>
<td>None</td>
<td>11</td>
</tr>
<tr>
<td>Digun</td>
<td>22 weeks</td>
<td>8</td>
<td>22</td>
<td>7</td>
</tr>
<tr>
<td>Dako</td>
<td>22 weeks</td>
<td>3</td>
<td>28</td>
<td>3</td>
</tr>
</tbody>
</table>

Results & Discussion MBL 1.0

- Of the 5 children, 4 emerged with vocals
- Taking 2 – 28 weeks
- Biso & Amaz had negligible fine and gross motor imitation
- Digun was most cooperative and had better eye contact but Biso, Amaz, Dako emerged with 1st vocal in 203 weeks
- Early vocal emergence in participants lacking observing responses suggests eye contact during stimulus-stimulus pairing might have little or no effect on vocal emergence. It may also rule out any blocking effect that the verbal auditory stimulus (presented during pairing) might have; as children with autism often exhibit stimulus over-selectivity.
- Training for observing response was initiated for Liv after 16 weeks as he did not acquire vocals
• While previous studies paired arbitrary words during SSP, in this study functional words were paired for lasting effects.
• Three participants had no histories of intervention and were below 4 years, however, Dako at the age of 13.5 years vocalized his first syllable in 3 weeks of intervention. This clearly demonstrates SSP can be effective in developing vocals in individuals with autism irrespective of age.
• The similarity of the emergent vocalizations to the paired auditory stimulus confirmed the role of automatic reinforcement during vocal emergence (Bijou & Baer, 1965; Skinner, 1957). Vocalizing /o-p/ for open, /jun/ for juice, /side/ for slide, and /ju/ for jump suggests SSP established the auditory-verbal stimulus as a conditioned reinforcer.

Results & Discussion MBL 1.0

Replication Participants: 53
Across 12 Multiple Baseline studies
83% Male & 17% Females
All non-vocal with a diagnosis of ASD
Participant Age range 1.4 – 9.6 years

Results Experiment 1
Total Participants: 58

48 (of n=58 mute) participants acquired vocals
Vocals acquired had permanent effects
Vocals emerged as phonemes, word or approximations
Vocals emerged across verbal operants mands, echoic mands and intraverbals but never as tacts
The vocal which emerged had similarities with the vocal paired
Results Study 1

- 24 of 58 participants who acquired vocals were <3.5 yrs.
- One male child 2.1 yrs did not acquire vocals
- Vocal emergence in <50 days

Results Experiment 1

- 3 participants reached mastery criteria (n=7 vocals) within 10 days
- 27 (of 58) participants acquired the 1st vocal between 25-50 days
- 3 participants emerged with all vocals on the same day
- Age may not be a criteria for vocalization - Youngest was 2.1 years Oldest 13.5 years

Discussion Experiment 1

- Sign- mand training with stimulus-stimulus pairing led to emergence of vocals in 83% participants
- 10 participants remained non-vocal
- A common variables among those who remained non-vocal was an overall low rate of learning (from IBI records). This requires further study

Study 2

Role of Sign Mand Training Using Time-Delay in 3 Non-Vocal Children With Autism

Introduction

- Tincani (2004) and Tincani, Crozier, & Alazetta (2006) found increase in vocal responses when PECS was used with time-delay.
Participant Selection

- 2 boys Ashar & Hipal already on the sign-mand training with vocal pairing for 33 weeks. Ashar joined later and was added to the study.
- No speech acquisition
- All at the same center
- Randomly selected for Experiment 2

Participants – Study 2

<table>
<thead>
<tr>
<th>Participant</th>
<th>Gender</th>
<th>Age</th>
<th>Diagnosis</th>
<th>BLA</th>
<th>EESA</th>
<th>N/O Intervention</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ashar</td>
<td>M</td>
<td>3.0</td>
<td>ASD</td>
<td>13/60</td>
<td>0</td>
<td>USA - 6 months, 27 hrs/week ABA</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>BM - 33 weeks Sign-mand training</td>
</tr>
<tr>
<td>Akron</td>
<td>M</td>
<td>2.8</td>
<td>ASD</td>
<td>12/60</td>
<td>0</td>
<td>9 months of Speech &amp; SI therapy</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Thrice/week BM - 9 weeks Sign-mand training</td>
</tr>
<tr>
<td>Hipal</td>
<td>M</td>
<td>2.6</td>
<td>ASD</td>
<td>22/60</td>
<td>0</td>
<td>Special school - Speech therapy 2 years + OT</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>BM - 33 weeks Sign-mand training</td>
</tr>
</tbody>
</table>

Preference Assessment

<table>
<thead>
<tr>
<th>Name</th>
<th>Toys</th>
<th>Outdoor</th>
<th>Edibles</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ashar</td>
<td>Toy, Blocks, Balloon, Music on Computer</td>
<td>Swing, Merry-go-round, Slide, Trampoline</td>
<td>Biscuit, Chips</td>
</tr>
<tr>
<td>Akron</td>
<td>Toy, Spoon, Spring toy</td>
<td>Merry-go-round, Gym-ball</td>
<td>French Fries, Grapes, Candy</td>
</tr>
<tr>
<td>Hipal</td>
<td>Ball, Music on Computer, Toy, Block, Bubble</td>
<td>Swing, Merry-go-round, Trampoline</td>
<td>Biscuit, Chips</td>
</tr>
</tbody>
</table>

Experimental Design

- Multiple Baseline across participants
- A participant was included when the previous participant acquired at least one instance of speech.

Response Definition, Measurement, IOA

Similar to previous study

Baseline
- Probes were conducted across mands, tacts, intraverbals and echoics. IOA was 100%

Intervention
- Probes similar as Expt 1
- IOA was 97% (range 94% - 100%)

Independent Variable

- Learner Demonstrates Interest
- Prompt Sign
  - 5 sec pause
- Therapist says target word
  - 2 sec pause
- Repeat target word
  - 2 sec pause
- Deliver item & pair target word

Treatment Integrity 90% (range 83-93%)
Results

- Ashar acquired 1st vocal in 1st week & 7th vocal in 7 weeks
- After he acquired 4 vocals IV introduced for Akon.
- Akon 1st vocal in 3rd week (ta=toy/ fie=fries)
- 8 week break. after another 5 weeks he acquired 2 mands
- On acquisition probe – 3 intraverbal fill-ins
- Hipal added as a 3rd participant as the pre-requisite for waiting for 5 sec was on target
- Hipal 1st vocal 9th week and 7th vocal 13th week all mands

Follow up: Week 30

- Ashar acquired 12 vocal mands, 6 intraverbal fill-ins and 14 echoics. EESA score at 30 weeks was 14/100
- Akon acquired 13 mands and 11 intraverbal fill-ins. His EESA score was 15.5/100.
- Hipal acquired 16 mands, 7 tacts, 8 intraverbal fill-ins and 25 echoics by week 30. His EESA score was 17.5/100
- This validates previous research on the effectiveness of time delay of 10-15-sec by Halle et al. (1979) and Ingenmey & Van Houten (1991) and 5 sec delay by Carbone et al (2010)

Discussion

- This study extends previous research by Carbone et al. (2010) with slight modifications in time-delays.
- The almost immediate emergence of vocals, within a week for Ashar and Akon adds to the evidence favoring the introduction of time-delay.
- Hipal had a long history of interventions including speech therapy and had previously been on mand training with SSP for 33 weeks. He emerged with vocals within 9 weeks

- Variability in behavior is induced in the delay period when reinforcement is withheld (Eisch, et al., 2002).
- The results in this experiment serve as a systematic replication of findings from Carbone et al. (2010) in which the independent variable was replicated except for two modifications. In the current experiment the vocal model after the initial sign was presented at 5 sec-2 sec-2 sec (9-sec) delay in comparison to 5sec-2sec-2sec-2sec (11-sec) delay in Carbone et al study.
- This study validates previous studies on the effectiveness of time-delay, increasing the waiting time from 2-sec during time-delay to 9-seconds with time-delays in the current study could evoke vocal behavior in some children
Study 3
Effect of Addition of Intraverbal Training Sign Mand Training

• Studies on intraverbal training have established a new repertoire of language development such as
  • storytelling (Valentino, Conine and Delfs, 2015),
  • reverse intraverbals (Allan, Vladescu and Kisamore, 2015),
  • bi-directional intraverbals (Dounavi, 2014),
  • yes-no responding (Shillingsburg, Kelley, Roane, Kisamore & Brown, 2009),
  • complex intraverbal responding (Sautter, LeBlanc, Jay, Goldsmith & Carr, 2011).
• Several studies have also focused on the variables impacting intraverbal acquisition (Coon & Miguel, 2012; Finkel, Williams, 2002; Grannan & Rehfeldt, 2012; Ingvarsson & Hollobaugh, 2011; Valentino, Shillingsburg & Call, 2012).

Literature review

• A review of titles in the journal the Analysis of Verbal Behavior published between 2010-16 reveals no studies that have explored the role of intraverbal training in the emergence of speech in non-vocal children with autism.
• Sundberg and Partington (1998) describe several procedures for teaching beginning intraverbal skills, to children with autism and other learning disabilities, using fill-in opportunities in songs, rhymes, animal sounds, object sounds, common associations and specific daily activities.

Experiment 3

Purpose:
To find alternatives when sign-mand training with vocal pairing failed to evoke speech
To study the effect of addition of a second independent variable: i.e. a verbal unit paired with target vocal (intraverbal fill-in) in inducing first instances of speech in children who remained non-vocal.

Participant Selection

Phase 1:
• 5 participants randomly selected.
• All were on sign-mand training with vocal pairing for an average 27-42 weeks
• Phase 2:
• The study was replicated across 41 more participants
• Previously on sign-mand training with vocal pairing for 12-52 weeks

Response Measurement

Baseline:
• Probes on intraverbals, mands, tacts, echoics
• IOA 100%
• Intervention:
• Daily first trial probes conducted on 3 AVU
• Specific vocal across 5 consecutive days triggered an IOA on relevant AVU
• Which was followed by probes on mands, tacts, echoics & intraverbals.
Expt. 3 MBL 1

- 5 participants (4 boys & 1 girl) Reyan, Neha, Barry, Mahar & Ricky
- Underwent Sign-mand training with SSP for 27-42 weeks
- Ages 1 year 11 months to 3 years 6 months
- No vocals acquired
- All except Barry received 25 hours/week IBI intervention

Expt. 3 - Participants

<table>
<thead>
<tr>
<th>Participant</th>
<th>Acquisitions</th>
<th>Age in Yrs./Mths</th>
<th>BLA 1</th>
<th>BLA 2</th>
<th>EESA</th>
<th>Duration of Intervention</th>
<th>Signs Acquired in Expt. 1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reyan</td>
<td>Rec 4 body parts, 3 OD.</td>
<td>1.11</td>
<td>20</td>
<td>22</td>
<td>0</td>
<td>28 weeks</td>
<td>12</td>
</tr>
<tr>
<td>Neha</td>
<td></td>
<td>3.6</td>
<td>13</td>
<td>21</td>
<td>0</td>
<td>32 weeks</td>
<td>9</td>
</tr>
<tr>
<td>Barry</td>
<td></td>
<td>3.2</td>
<td>12</td>
<td>20</td>
<td>0</td>
<td>42 weeks</td>
<td>1</td>
</tr>
<tr>
<td>Mahar</td>
<td></td>
<td>3.2</td>
<td>12</td>
<td>20</td>
<td>0</td>
<td>30 weeks</td>
<td>4</td>
</tr>
<tr>
<td>Ricky</td>
<td></td>
<td>3.2</td>
<td>12</td>
<td>16</td>
<td>0</td>
<td>27 weeks</td>
<td>2</td>
</tr>
</tbody>
</table>

Experimental Design

Multiple baseline design

Each participant was added when the previous acquired, at least one vocal

Independent Variable

Therapist presents Antecedent Verbal Unit (AVU)
(Ex: initial part of rhyme or fun-fill-in)

pauses 2 seconds

pairs target verbal stimulus with delivery of preferred item.

(Multiple words do not equal to multiple stimuli and may function as a single unit. Eikeseth, 2013; Skinner, 1957)

Intraverbal Training

Johnny3 Yes, … (1-2 sec pause) ……… “Papa” Preferred item delivered (Antecedent Verbal Unit) (Paired stimulus)

One, Two, … (1-2 sec pause) ……… “3” — Preferred item delivered (Antecedent Verbal Unit) (Paired stimulus)

Cow says ……… (1-sec pause) ……… “Moo” Preferred item delivered (Antecedent Verbal Unit) (Paired stimulus)

20 Intraverbal Training Trials conducted / session
Expt. 3 Baseline Video

Video Intraverbal training Video

Intraverbal vocal emergence

Intraverbal vocal emergence

Figure S2A shows baseline versus post-test tongue movement with enhanced feedback in children with autism.
### Results: Expt 3 MBL 1

<table>
<thead>
<tr>
<th>Participant</th>
<th>Period of Intervention</th>
<th>Week to 1st Vocal</th>
<th>Week to 7th Vocal</th>
<th>1st Vocal Operant</th>
<th>Vocal Operant</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reyan</td>
<td>19 weeks</td>
<td>1</td>
<td>19</td>
<td>Intraverbal</td>
<td>4 Intraverbal</td>
</tr>
<tr>
<td>Neha</td>
<td>33 weeks</td>
<td>4</td>
<td>33</td>
<td>Intraverbal</td>
<td>3 Intraverbal</td>
</tr>
<tr>
<td>Barry</td>
<td>15 weeks</td>
<td>9</td>
<td>15</td>
<td>Intraverbal</td>
<td>5 Intraverbal</td>
</tr>
<tr>
<td>Mahar</td>
<td>44 weeks</td>
<td>16</td>
<td>44</td>
<td>Intraverbal</td>
<td>7 Intraverbal</td>
</tr>
<tr>
<td>Ricky</td>
<td>50 weeks</td>
<td>None</td>
<td>None</td>
<td>None</td>
<td>None</td>
</tr>
</tbody>
</table>

#### Results Expt 3 MBL 1

- Four participants achieved n=7 first instances of speech.
- Reyan’s 1st two vocals were Intraverbal fill-ins. After the 2nd vocal on the acquisition probe he emerged with 3 echoics, but no mands
- Neha’s 1st four vocals were fill-ins. Her 5th vocal emerged as an echoic mand
- Barry’s first 7 vocals were all fill-ins
- Mahar’s 1st vocal was a fill-in, while the next 2 were echoic mands
- Ricky did not acquire any vocals.

### Study 3 Replications

- Replication Participants: 41
- Multiple Baselines: 9 + 2 single subjects
- Gender: Male 77% & Female 23%
- Age range: 1.8 – 12.2 years
- Each MBL had 3-7 participants

### Results Experiment 3

- Total Participants: 46
- Mean IOA 88% (74% – 97%)

---

**Note:** The tables and diagrams are not fully visible in the image, but the text provides the necessary information. Further details might be required for a complete understanding of the experiment results.
Results Experiment 3
Total Participants: 46

Expt 3: Results

- 37 of 46 participants acquired n=7 first instances of speech.
- 9 participants emerged with first vocals within 2 weeks confirming the effect of the independent variable
- Almost 20 participants took an average .46 days/vocal suggesting long intervals.
- Four participants emerged with all 7 first instances as intraverbal fill-ins.

Discussion

- Results suggest Intraverbal training with paired words affected emergence of vocals.
- The Antecedent Verbal Unit was established as a discriminative stimulus
- Faulty stimulus control (Sheep says baa & not moo) was not observed with any child as an outcome.
- The 1-2 second delay showed pairing effects
- One pairing was effective

Limitations & Future Research

- More research required for pairing an antecedent verbal unit with non-vocal children with autism and other developmental disabilities
- The role of Antecedent Verbal Unit needs further study with non-vocal children
- Faulty stimulus control (Sheep says baa & not moo) was not observed with any child.
- The 1-2 second delay showed pairing effects
- One pairing was effective

Study 4

The Effect of Sign Mand Training and Intraverbal Training as a Treatment Package with Non-Vocal Children With Autism

IOA 89% (Range 83%-94%)

Purpose

To observe any changes in rate of vocal emergence when intraverbal training with paired vocal is started along with mand training as a treatment package
Expt 4 - Participants

<table>
<thead>
<tr>
<th>Participant</th>
<th>Gender</th>
<th>Age in Yrs./mths</th>
<th>BLA</th>
<th>EESA</th>
<th>Multiple Baseline #</th>
</tr>
</thead>
<tbody>
<tr>
<td>Narvey</td>
<td>M</td>
<td>5.6</td>
<td>18</td>
<td>0</td>
<td>4.2</td>
</tr>
<tr>
<td>Huber</td>
<td>M</td>
<td>5.2</td>
<td>26</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Rita</td>
<td>F</td>
<td>3.6</td>
<td>19</td>
<td>0</td>
<td></td>
</tr>
</tbody>
</table>

Response measurement & IOA

- Data collected as Yes/No
- Intake Assessments: BLA & EESA
- Baseline Probes: Mands, Tacts, Echoics & Intraverbals
- Intervention Probes:
  - First mand & First Intraverbal trial of the session
  - Vocal emergence for 5 days followed by an IOA by supervisor
  - Assessment as in Baseline on Mands, Tacts, Echoics & Intraverbals

Independent Variable

Treatment Integrity Scores:
- Intraverbal Training: 87% (Range 60% - 100%)
- Mand Training: 86% (Range 77% - 100%)

Expt 4 - Participants

<table>
<thead>
<tr>
<th>Participant</th>
<th>Weeks to 1st vocal</th>
<th>Weeks to 7th Vocal</th>
<th>7th Vocal under Operant</th>
<th>Multiple Baseline #</th>
</tr>
</thead>
<tbody>
<tr>
<td>Narvey</td>
<td>6</td>
<td>12</td>
<td>Intraverbal</td>
<td>4.2</td>
</tr>
<tr>
<td>Huber</td>
<td>1</td>
<td>4</td>
<td>Intraverbal</td>
<td></td>
</tr>
<tr>
<td>Rita</td>
<td>1</td>
<td>4</td>
<td>Mand</td>
<td></td>
</tr>
</tbody>
</table>

Results Expt. 4 MBL 4.2

Expt 4:

Total Participants: 19
Multiple Baselines: 5
Gender: Males 85%
Females & 15%
Age range: 1.8 – 9.2 years
Diagnosis: ASD
Results

- 17 of the 19 i.e. 89% participants acquired vocals
- Of the 17 participants 16 kids took 5-23 days for each vocal.
- RGA at 8.6 years was the outlier who took 48 days for each vocal taking 338 days for mastery. Past h/o of 5 years at a special school.
- JRA a 9.2 years old boy, was using PECS and had a h/o OT, Speech and ABA based intervention. He first vocalized in 35 days and met mastery in 155 days.

Vocal Status

11% Remained Non-Vocal
89% Acquired Vocals

Mean IOA 89% (83% – 94%)

Discussion

- 105 of 126 non-vocal kids with autism benefitted from behavioral interventions and acquired vocals. This contrasts with (Eldevik, Jahr, Hastings & Hughes, 2010) recommendations
- Strong evidence of the role Stimulus-stimulus pairing played in pairing neutral target sounds with preferred item adds the evidence (Caroll & Klatt, 2008; Esch et al., 2009; Miguel et al., 2002; Smith et al., 1996; Sundberg et al., 1996; Ward et al., 2007; Yoon & Bennett, 2000).
- SSP under motivating operations was effective in vocal emergence.

Conclusion

- The efficacy of the procedures was demonstrated across all four interventions.
- Two interventions (Experiment 1 & 2) included sign-mand training with vocal pairing with delay of 2-9 seconds
- Two interventions (Experiment 3 & 4) included the addition of a second independent variable i.e., pairing a target word with an antecedent verbal unit (AVU) after a delay of minimum 12 weeks or as a treatment package.

Vocal Emergence By Experiments

<table>
<thead>
<tr>
<th>Participants / Experiment</th>
<th>Expt 1</th>
<th>Expt 2</th>
<th>Expt 3</th>
<th>Expt 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Non Vocal Participants</td>
<td>58</td>
<td>3</td>
<td>46</td>
<td>19</td>
</tr>
<tr>
<td>Acquired Vocals</td>
<td>48</td>
<td>3</td>
<td>37</td>
<td>17</td>
</tr>
<tr>
<td>Remained Non-Vocal</td>
<td>10</td>
<td>0</td>
<td>9</td>
<td>2</td>
</tr>
<tr>
<td>% Vocalized</td>
<td>83%</td>
<td>100%</td>
<td>80%</td>
<td>89%</td>
</tr>
</tbody>
</table>

Vocalization By Participant Age

<table>
<thead>
<tr>
<th>Age in Years</th>
<th>Total Participants</th>
<th>Achieved Vocals</th>
<th>% Vocalized</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.4 – 3.0</td>
<td>44</td>
<td>34</td>
<td>83%</td>
</tr>
<tr>
<td>3.1 – 8.0</td>
<td>38</td>
<td>66</td>
<td>84%</td>
</tr>
<tr>
<td>8.1 – 13.5</td>
<td>6</td>
<td>6</td>
<td>83%</td>
</tr>
<tr>
<td></td>
<td>126</td>
<td>105</td>
<td></td>
</tr>
</tbody>
</table>

- The role of signs as prompts for facilitating communication is supported by the following data taken by one team at Hyderabad across all expt. (Tincani, 2004)

<table>
<thead>
<tr>
<th>S.No</th>
<th>MBCL</th>
<th>Code Name</th>
<th>Total Sign-mands prior to vocals</th>
<th>Vocal / Non-vocal</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1.11</td>
<td>SVEE</td>
<td>14</td>
<td>V</td>
</tr>
<tr>
<td>2</td>
<td>1.12</td>
<td>VKI</td>
<td>2</td>
<td>V</td>
</tr>
<tr>
<td>3</td>
<td>1.12</td>
<td>ZVA</td>
<td>2</td>
<td>V</td>
</tr>
<tr>
<td>4</td>
<td>1.12</td>
<td>SRE</td>
<td>20</td>
<td>NV</td>
</tr>
<tr>
<td>5</td>
<td>1.12</td>
<td>AQU</td>
<td>2</td>
<td>V</td>
</tr>
<tr>
<td>6</td>
<td>1.13</td>
<td>FKE</td>
<td>3</td>
<td>V</td>
</tr>
<tr>
<td>7</td>
<td>1.13</td>
<td>MAR</td>
<td>14</td>
<td>V</td>
</tr>
<tr>
<td>8</td>
<td>1.13</td>
<td>AAR</td>
<td>11</td>
<td>V</td>
</tr>
<tr>
<td>9</td>
<td>3.3</td>
<td>ISIR</td>
<td>5</td>
<td>V</td>
</tr>
<tr>
<td>10</td>
<td>3.3</td>
<td>SAV</td>
<td>12</td>
<td>V</td>
</tr>
<tr>
<td>11</td>
<td>3.4</td>
<td>SVEN</td>
<td>24</td>
<td>V</td>
</tr>
<tr>
<td>12</td>
<td>4.4</td>
<td>MMA</td>
<td>0</td>
<td>V</td>
</tr>
</tbody>
</table>
**First instances of speech had permanent effects unlike previous studies** (Miguel et al. 2002; Normand & Knoll, 2006)

- The selection of target words after a preference assessment
- Ensuring satiation was offset and MO remained high for 40 trials/day
- Conducting teaching trials after participants demonstrated desire (Shillingsberg et al., 2015)
- Establishing the mastery criteria to achieve permanent vocals.

---

**Mand training**

- an effective strategy (Drash et al., 1999; Ross & Greer, 2008)
- produced stronger effects on various dimensions of response (Staffort, Sundberg & Bram, 1988)
- needs more research with non-vocal children

---

**Selection of an AAC system**

- attributed to individual variables such as pre-existing skills, individual needs and family preferences (Mirenda, 2005)
- While improvements in vocalization demonstrated in stage IV of PECS (Carr & Felce, 2007; Tincani et al., 2004; Yoder & Stone, 2006). 
  Emergence weak.
- Mixed needs obtained with the use of SGD’s (Olwe et al, 2007; Rocha et al., 2014; Schlosser et al., 2007)
- Current research provides strong evidence of using manual sign training under mand conditions using SSP

---

**Selection of signs (unaided AAC)**

- due to cost factors, training efforts, limited response effort of preparing materials and ease of usage.
- Unlike previous studies (Ganz et al., 2002; Rose, Trembath & Bloomberg, 2016) despite limited imitation skills, most participants acquired manual signs under MO

---

**Pairings during SSP**

- considered a significant variable for increasing post-pairing vocalizations.
  - Paired once (Miliotis, et al., 2012; Smith et al., 1996; Sundberg et al., 1996; Ward et al., 2007; Yoon & Bennett, 2000; Yoon & Feliciano, 2007)
  - Paired thrice (Esch et al., 2007; Esch et al., 2009; Lepper et al., Rader et al., 2007)
  - Paired 5 times (Caroll & Klatt, 2008; Miguel et al., 2002; Stock et al., 2008)
- Studies with no increase in vocalizations (Esch et al., 2005; Normand et al., 2006; Stock et al., 2008)
- Current study used 3 pairings during mand training with 126 children and 1 pairing during intraverbal training

---

**Pairings with an Antecedent Verbal Unit (AVU)**

- Novel experiment on non-vocal children
- Pairing effects are most visible as the number of vocals which emerged were significantly higher when animal sounds were paired followed by a delivery of
## Limitations

- Dependence on BLA as an assessment tool
- Collateral effects of IBI on speech emergence not studied
- The effect of pairing the word 3 times in mand and once with the AVU
- Factors leading to difference in rate of acquisition were not clear
- Maturation effects due to the long intervals of vocal emergence could be a possibility with some children

---

Thank You
Email: smita.awasthi@behaviormomentum.com