Using Stimulus Pairing Procedures to Increase Vocalizations

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Background

Up to half of young children diagnosed with ASD present with language delay (Hudry et al., 2010; McCann et al., 2005)

Vocal communication is typically among the goals of early intervention for non-speaking toddlers and young preschoolers (see e.g., Leaf & McEachin, 1999; Lovaas, 2003; Sundberg & Partington, 1998; Sundberg, 2008).

May be difficult to accomplish for children who do not engage in vocal play or echolalia or produce many recognizable phonemes

Stimulus pairing (a.k.a. “stimulus-stimulus pairing”) refers to temporally contiguous presentations of speech sounds and preferred items

Recommended in some early intervention texts as a way to increase child vocalizations (Greer & Ross, 2008; Sundberg & Partington, 1998; Sundberg, 2007)

Common questions:
- Why would we expect this to work?
- Does it work?
- How should I do it?

WHY WOULD WE EXPECT IT TO WORK?
Cooing

Variability, prosody, stimulus control

Canonical Syllables

Why do Birds Sing?

Social feedback (e.g., King & West, 1983; King, West, & Goldstein, 2005; Smith, King, & West, 2000; Marler & Nelson, 1991; West & King, 1988)
Why do Babies Babble?

Parents respond socially to a majority of infant prelinguistic vocalizations (e.g., Gros-Louis, West, Goldstein, & King, 2006).

Contingent attention increases rate and phonological quality of vocalizations (Goldstein, West, & King, 2003; Wu & Gros-Louis, 2016).

The greater the density of contingent attention, the sooner the child achieves early language milestones (Tamis-Lemonda, Bornstein, & Baumwell, 2001).

But... infants babble more when playing alone than when interacting with adults (Harold & Barlow, 2013).
Why do Babies Babble?

Native language and prosody of crying (Mampe et al., 2009; Wermke et al., 2016)

If parents respond to all infant vocalizations with specific types of vocalizations of their own, the infants' production of similar vocalizations increases (Goldstein & Schwade, 2008)

Why do Birds Sing?

Social feedback (e.g., King & West, 1983; King, West, & Goldstein, 2005; Smith, King, & West, 2000; Marler & Nelson, 1973; West & King, 1988)

Auditory feedback from own song after exposure to mature song (see Brainard & Doupe, 2000)

Automatic Reinforcement

Long been hypothesized to operate in the acquisition of human babbling (e.g., Mowrer, 1960; Skinner, 1957)
How can we establish speech sounds if a child is not making any?

**Socially mediated reinforcement:** Supplement social attention with more effective reinforcers

**Automatic reinforcement:** Increase the reinforcing value of speech sounds

Drawbacks:
- Requires a therapist skill that is difficult to teach
- Time-consuming
- Not always possible (Lovaas, 2003)

Shaping Speech Sounds Via Contingent Delivery of Preferred Items

Demonstrated in a number of studies (e.g., Drash, High & Tudor, 1999; Fineman, 1968; Lovaas, Berberich, Perloff, & Schaeffer, 1966)

Using Lag Reinforcement to Increase Variability of Vocalizations

Requires phoneme variability in baseline

Implementation requires fine discriminations between phonemes
How can we establish speech sounds if a child is not making any?

Socially mediated reinforcement:
Supplement social attention with more effective reinforcers

Automatic reinforcement:
Increase the reinforcing value of speech sounds

Stimulus Pairing Procedures

“Bah”

Does it work?
## Stimulus Pairing Procedures

Reliable effect on child vocalizations demonstrated in **several studies** (Esch, Carr, & Grow, 2009; Lepper & Petursdottir, 2017; Lepper, Petursdottir, & Esch, 2013; Miguel, Carr, & Michael, 2002; Miliotis et al., 2012; Rader et al., 2014; Smith et al., 1996; Sundberg et al., 1996; Yoon & Bennett, 2000)

- The resulting vocalizations are not echoic and not a product of incidental reinforcement by the preferred items
- The effect is not due to repeated modeling of sounds or presentation of preferred items; pairing is necessary
- Paired items must be reinforcers (Smith et al., 1996)

Failures to produce the effect have also been reported in the literature (Carroll & Klatt, 2008; Esch, Carr, & Michael, 2005; Miguel et al., 2002; Normand & Knoll, 2006; Stock, Schubie, & Mirenda, 2008; Yoon & Feliciano, 2007)

- Novel intervention and “implausible” effect – easier to publish negative results?
- Procedural variability across studies
- Little is known about variables that impact outcomes

Although many studies have demonstrated **effects** on speech-like vocalizations, that does not mean we have demonstrated either the **efficacy** or the **effectiveness** of the procedure.

### But does it really work?

Does the increase in speech sounds actually help establish functional vocal communication?

Carroll and Klatt (2008):
- **Effect of stimulus pairing on the vocalizations** of 1 of 2 participants
- That participant’s target vocalization was successfully brought under echoic control

**Moderate overall effect size**

**Positive outcomes for two-thirds of all participants**
But does it really work?

A few studies have additionally demonstrated that after vocalizations emerge via stimulus pairing, differential reinforcement can produce a further rate increase (Esch et al., 2009; Lepper & Petursdottir, 2017; Yoon & Feliciano, 2007)

But no assessment of *mand function* or other verbal operant function reported

Lepper & Petursdottir (2017): Experiments 1 and 2
Experiment 3; not included in published version

Participant Gabe's history:

(1) Two sounds ("day" and "moo") paired with the same preferred item. Rate of emission of both sounds increased.

(2) Differential reinforcement of both sounds with different preferred items; rate increased further

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Lepper (2014)
Participants in Lepper & Petursdottir (2017)

Participant Gabe's history:

1. Two sounds ("day" and "moo") paired with the same preferred item. Rate of emission of both sounds increased.
2. Differential reinforcement of both sounds with different preferred items; rate increased further.

Lee and Ken had the same history, except in the second phase, access to the same preferred item was contingent on both sounds.
But does it really work?

The existing data are preliminary and additional data are needed to demonstrate clinically meaningful outcomes.

But the same is true of other procedures that have been used to get non-speaking children to vocalize:

- Shaping
- AAC systems

HOW SHOULD I DO IT?

Not enough literature to provide clinical guidance.
Who is a candidate for stimulus pairing?

An anonymous reviewer’s perspective: Nobody, due to lack of data showing clinically meaningful outcomes . . .

. . . but this would mean that we should never work on getting non-speaking children to vocalize at all....

Effect has been demonstrated in children up to 8 years of age (Milojevic et al., 2012) but may be more likely to occur under the age of 5 years (Shillingsburg et al., 2015)

Little known about child characteristics that predict success (Shillingsburg et al., 2015).

Selecting Sounds for Pairing

Some studies have paired novel sounds and others have paired low-frequency in-repertoire sounds (see Shillingsburg et al., 2015)

No data exist to support one practice over the other.

Some studies have targeted novel syllables that combine in-repertoire elements (Lepper, Petursdottir, & Esch 2013; Lepper & Petursdottir, 2017)

- Example: “Moo” and “Ba” are in repertoire but “Boo” is not

Selecting Preferred Items

What is the immediate purpose of the intervention?

1. No appropriate mand repertoire ----> mands
2. Existing non-vocal mand repertoire ----> echoics

For #1, select target sounds that approximate names of preferred items?

For #2, multiple exemplars?

RESEARCH NEEDED

Use preference assessment and consider reinforcer assessment (Shillingsburg et al., 2015); monitor MQ presence

Early studies (e.g., Sundberg et al., 1996) used mostly social reinforcers, but larger effects have been associated with edible reinforcers (Shillingsburg et al., 2015).

Most studies have used multiple preferred items (see Petursdottir & Lepper, 2015)

- Rotated within session
- Rotated across sessions based on participant selection
- Not clear if one strategy is better than another (Petursdottir, Carp, Matthews, & Esch, 2011)
Selecting Preferred Items

Some studies have used only one highly preferred items across all sounds, sessions and trials for experimental control purposes (Lepper, Petursdottir, & Esch, 2015; Lepper & Petursdottir, in press).

No studies have paired specific sounds with specific preferred items!

Pairing Sounds and Preferred Items

How many times should a target syllable be presented each times it is paired with the preferred item?

- Ranges from one to seven in the literature
- Fewer (1) presentations may be better than more (3) presentations (Miliotis et al., 2012)
- No clear relationship between presentation arrangement and effect, so more research is needed (Shillingsburg et al., 2015)

Pairing Sounds and Preferred Items

Should the target sound be presented in a specific tone of voice?

- Some studies have reported using “motherese” or varied intonation patterns (Esch et al., 2009; Miliotis et al., 2012; Rader et al., 2014; Sundberg et al., 1996)
- Most studies include little information on delivery
- Unclear if this is an important variable (Petursdottir & Lepper, 2015; Shillingsburg et al., 2015)

Pairing Sounds and Preferred Items

How should the presentation of the sound and the preferred item be arranged temporally?

- Typically delay or trace pairing (Shillingsburg et al., 2014)
  - Supported by respondent conditioning literature, but no evaluations within stimulus pairing literature.
When to pair? How often?

- Variable across studies; greater density of pairings is associated with weaker effects (Shillingsburg et al., 2015)
- Increasing the number of pairings per session may not affect preference for target sound (Petursdottir, Carp, Matthies, & Esch, 2011)
- Perhaps more important to deliver at the “right” times? (Shillingsburg et al., 2015)
- Response-contingent pairing may have a larger effect than response-independent pairing (Lepper & Petursdottir, in press)

Pairing Sounds and Preferred Items

Intertrial interval determined by child’s response

A more clinically relevant response could involve gazing at or reaching for preferred item (Shillingsburg et al., 2015)

Reinforcing Target Vocalizations

Typically not done in research studies on stimulus pairing

- Scheduled delivery of preferred items may be even be omitted if target vocalization occurs

Paradoxically, omitting reinforcer delivery after a vocalization is associated with a stronger effect in the literature (Shillingsburg et al., 2015)

- Likely due to confounds with other variables
In clinical practice, every occurrence of a target vocalization should be reinforced (Petursdottir, personal opinion).

Primary concern: Whether the procedure is helpful; not why!

Including Nontarget Sounds

A sound that is presented in pairing sessions but not followed by preferred item delivery (Esch et al., 2009; Lepper et al., 2013; Miliotis et al., 2012; Rader et al., 2014)

Intended as a control procedure

Could inclusion of nontargets enhance the effect? (Esch et al., 2009)

Additional research needed.

How Long to Continue?

An effect is usually evident after 1-5 sessions (Esch et al., 2009; Lepper et al., 2013; Miguel et al., 2002; Miliotis et al., 2012; Rader et al., 2014)

Consider whether failure to find an effect might be due to
• Preferred items not functioning as reinforcers
• Some aspect of the procedure

Discrimination training if stimulus pairing fails? (Lepper et al., 2013; see also Taylor-Santa, Sidener, Carr, & Reeve, 2014)
In Summary . . .

Many questions remain unanswered regarding effective implementation and the literature has not reached sufficient maturity to afford best-practice recommendations.

Procedural variables that need to be studied include several aspects of target sound presentation, density of pairings, and inclusion of control sound.

Most importantly, research is also needed to confirm the clinical significance of the effect.

In Summary . . .

Meanwhile, stimulus pairing is a conceptually sound procedure for increasing vocalizations.

The literature clearly does support an effect on (nonfunctional) vocalizations.

It is easier than shaping and can be taught to parents.

There is not other clearly better alternative.

It does not take very long to evaluate whether or not a child responds to it.