What do you think of when you hear the word Fluency...
Introduction

Definitions

- From Wikipedia: Fluency is a speech language pathology term that means the smoothness or flow with which sounds, syllables, words and phrases are joined together when speaking quickly.

https://www.youtube.com/watch?v=yjMXMAKF-Rg
The U.S. Department of Education provides federal funding for school and district efforts to improve educational achievement only when the school's reading program includes:

- Phonemic awareness
- Phonics
- Fluency (i.e., rate of passage reading)
- Vocabulary
- Comprehension


The Depart of Ed also recommends:

• fluency with whole numbers and fractions as key to algebra success, a marker of more general student success:
• . . . automatic recall of addition and related subtraction facts and of multiplication and related division facts, and fluency with the standard algorithms for addition, subtraction, multiplication and division.”

» US Dep’t Ed, National Mathematics and Advisory Panel, 2008 11
From Morningside Academy Summer Institute (K.Johnson).
Fluency: accuracy and rate

“possessing knowledge” is possessing behavior. (Skinner)

Don’t Panic...
Historical Lesson: Fluency

Legacy from Skinner and Ogden Lindsley

Farewell my lovely
(Skinner, 1976)
B.F. Skinner and Fluency

- Involves the rate of responding.
- Skinner considered rate of response and the cumulative response recorder to be his major contributions (Skinner 1976)
- “Rate is a universal datum”
Cumulative response recording features:

1. Self recording: “Made by the rats themselves” (Skinner, 1938, p.60)
2. Objective and reliable: “the experimenter doesn’t intervene”
3. Slope: 2 dimensions (number per minute).
4. Slopes are standard
5. Displays major changes (equal angular changes for major changes in frequency)
6. Frequencies displayed on a multiply scale. (eventually learn the value of the slope) to assess learning / magnitude of changes.

- Precision teaching took the slope (number per minute) of Skinner’s cumulative records and charted it up the left of the standard acceleration chart on a logarithmic scale.
- The size was adjusted so that a line from the lower left corner to the upper right corner represented a doubling in frequency every seven days.
- Standard is the meaning of the slope just as was the case with the cumulative record
- The cumulative record would more properly have been called the standard frequency record, describing it by its slope rather than by its vertical scale.
Precision teaching

- Adjusting the curricula for each learner to maximize learning.
- The instruction can be by any method or approach.
- The most effective applications of Precision teaching has been when it is combined with Direct Instruction (Johnson, 1989, Maloney & Humphrey, 1982)
  - Decisions are made on a weekly basis but data is recorded daily.
  - Precision teaching began in 1965. In a special education classroom at KU.
  - Haughton expanded the work in the 1970s (University of Oregon).

Lindsley 1962

- Laboratory research had shown human behavior frequencies to be 10 to 100 times more sensitive to changes in procedures than percent correct
Precision teaching

Morningside Model

Standard Celeration chart: Sample graph

- Dots: behavior increasing
- X: errors decreasing.
- -: timing floor
Comparison of measurement: are the skills of equal strength?

Fluency measures

Percent correct
Problems with equal interval graphs

Standard Celeration

Advantage of the chart
“Rate is a universal datum.” Skinner

- in Skinner’s statement, I saw the opportunity for putting all behavior of all organisms on a frequency spectrum, as previously had been done with light, sound and electricity. In our laboratory research on chronic psychotics, I had record the frequencies of human plunger pulling, pacing, talking, looking and listening (Lindsley, 1956, 1960, 1962). Once we had all behaviors plotted on a frequency spectrum, I was convinced major behavioral discoveries would soon follow.

- Background in biology and engineering.
- Example of light qualities (differences on a frequency spectrum) “accomplishes wonders of radiance” (P.254)

Ogden Lindsley
Behavioral Fluency is the combination of accuracy plus speed of responding that enables competent individuals to function efficiently and effectively in their natural environments.
(Binder, 1996)

Behavioral Fluency

Other terms equated with fluency:

“automatic”  
(Haughton, 1972a)

“second nature performance”  
(Binder, 1990)

“doing the right thing without hesitation”  
(Binder, 1988b)

“Stability or predictability of performance”  
(Barrett 1977a)

“immediately accessible”  
(Gagne, 1970,1974)

“Performed with perfect confidence”  
(Gagne & Briggs, 1974)

“Fluency features resemble mastery.”  
(Binder, 1996).
Effects of fluency:
When learners achieve certain frequencies of accurate performance

1. Retain & maintain what they have learned
2. Remain on task or endure for sufficient periods of time to meet real-world requirements
3. Even in the face of distraction
4. And apply, adapt, or combine what they learned in new situations

B.F. Skinner (1938) pursued research in which “rate of responding is the principal measurement of the strength of an operant”
Fluency represents a new paradigm

In the analysis of complex behavior and the design of instruction

Accuracy is not sufficient

Haughton observed that the mere presence or accuracy of a response class in the repertoire of a learner is not sufficient to ensure progress through a curriculum sequence that depends on that response class as a prerequisite or component.

Just because someone can do something doesn’t mean it is a mastered skill.
Principle of minimum component behavior frequencies.

Set the stage for significant improvements in efficiency of instructional programming.

Increase the frequency of composite skills by increasing the frequency of the component skills.

Increase complex behaviors by increasing the rate of responding/strength of the component skills.

Haughton analogy

Like atoms requiring a certain valence or energy to combine

behavioral elements require a certain frequency to form compound response classes.
David Palmer
Atomic Repertoires

A set of fine-grained units of behavior, each under control of a distinctive stimulus, that can be evoked in any permutation by the arrangement of corresponding stimuli.

Building complex human behaviors

Building blocks of complex behavior – arise from other response classes that have been shaped bit by bit.

By appropriate arrangement of these discriminative stimuli, an indefinite number of permutations of atomic units can be evoked.

Behavioral atom: “a string of atomic responses can be specified by a small set of instruction, and once the responses have occurred in the correct sequence, they may hang together as a unit under control of prevailing contingencies.”
“The secret of attaining excellence is to always maintain close attention to every detail of performance ‘each one done correctly, time and again, until excellence in every detail becomes a firmly ingrained habit’

Atomic Repertoires.

Fluency

• Accuracy to mastery
Examples of atomic repertoires

- **Echoic behavior:**
  - Speaker as a listener
  - Parity
  - Grammar
  - Shapes language
  - Imitation
  - Used in novel situations
  - Observational learning

- **Tacting behavior:**
  - Recall strategy
  - Joint control
  - Responding as a listener
  - Observational learning
We want our learners to perform complex skills...

*We must teach the basics not only accurately but fluently.*

video
Teaching is not only producing new behavior, it is also changing the likelihood that a student will respond in a certain way. Since we cannot see a likelihood, we look instead at how frequently a student does something. We see how fast he can add. The student who does problems correctly at a higher rate is said to know addition facts better than one who does them at a lower rate. (p. 62).

Fluency as a teaching tool

“What many educators assumed to be ‘learning disabilities’ or ‘learning problems’ seemed to wane when students were allowed and encouraged to practice key components of complex behavior to the point at which they could perform each component at relatively high frequencies.”
Gilbert (1978)

Educational programs will be more effective in the long run if they produce a more focused, but truly mastered, repertoires rather than a broad but fragile repertoire.

Tiemann and Markle (1990)

1. Analyze and sequence curriculum to encourage generativity

2. The emergence of new behavior based on the principle of contingency adduction.
Johnson & Layng (1992, 1994) When the basics are fluent, later learning becomes easier rather than more difficult.

Basic Math fact

2 + 2 = ?
More complex math problem

Component-Composite

Examples from Research involve fluency with:

- Reading
- Writing
- Computational math
- Fine and gross motor control (Big 6+6)
- Physical, occupational and language therapist.
- Self care and vocational skills. (practicing components in isolation prior to combining them into chains).
Example
Math component/composite
(Morningside Academy)

Issues with fluency

Drill and practice
• Lack of reinforcement
• Working too much under aversive control

Prolonged practiced when the frequencies are low
• Skills are not ready for fluency building.
• There is no goal, aim or insufficient goals/aims.
Setting Aims

Are a specific and precise objective of an overall goal

Educational aims should be personalized to fit each student.

Haughton, 1972
Considerations for fluency aims

- **Accuracy** – rate of correctness/incorrectness during run-throughs.
- **Speed** – responses per minute.
- **Duration** – endurance, attention span, and resistance to distractions during the timing.
- **Stability** – the ability to engage in the skill easily in the face of distractions.
- **Retention and maintenance of skills and knowledge.**

**MESAA**

- Maintenance
- Endurance
- Stability
- Application
- Adduction

- We should set aims that are empirically determined levels of performance ensure retention and application of skills.
- Achieving high performance frequencies increase the likelihood that students would maintain attention to task over extended durations of performance in the face of distraction.
Fluency data: typical children 15-48 months

Chart of Operant Rates based on typical developing children (15-48 months)

<table>
<thead>
<tr>
<th>Operant</th>
<th>Age</th>
<th>Responses per minute</th>
<th>Number of accurate responses (approximations)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Imitation</td>
<td>15-20 months</td>
<td>6 rpm</td>
<td>Under 10 imitations</td>
</tr>
<tr>
<td></td>
<td>22-29 months</td>
<td>30-48 rpm</td>
<td>More than 10</td>
</tr>
<tr>
<td></td>
<td>30-42 months</td>
<td>36-54 rpm</td>
<td>More than 20</td>
</tr>
<tr>
<td></td>
<td>42-48 months</td>
<td>48-54 rpm</td>
<td>++</td>
</tr>
<tr>
<td>Echoic</td>
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Building fluent skills for children with autism.

Imitation aim (30-50 rpm)

Echoic aim (40-60 rpm)

Listener Responding aim (30-50 rpm)

Tact aim (50-60 rpm)

**Fluency within Intensive teaching**

- Use card sort to keep instruction at a fast pace.
- Consider any answer that takes longer than 2 seconds an error.
- Keeps responses fluent.
- Keeps problem behaviors and distractions at a minimum.
- Avoids errors on basic skills.
3 phases of learning and teaching (K. Johnson)

- **Phase 1: instruction.** (teach to accuracy)
- **Phase 2: practice.** (teach to fluency)
- **Phase 3: application** (teach to generalization and application)

Promote generativity throughout.

These phases may not be totally linear (phases 2 and 3 should be embedded in phase 1).
Pace of Instruction

Faster responding results in less problem behavior and/or off task behavior.

video
In a teaching session:

• you can tell fluency by how much time between the direction or $S^d$ and the response.

When more practice is needed:

When someone says: he can do that but

• He is distracted
• He is not retaining skills
• He can do it but not all the time
• Slow to respond in intensive teaching or NET for a certain skill.
Programming for fluency

Tact fluency
When to consider TACT fluency

- When slow at responding with tacts during Intensive teaching
- Slow at responding with tacts in Natural environment
- If student has difficulty such as distractions, memorization issues, generalization issues, prompt dependency/spontaneous issues.

MORE considerations for tact fluency

- Should probe/teach tact fluency before more complex programs: Intraverbals.
- Should probe/teach tact fluency before joint control programs.
- If student has problems with more advanced programs (retention, acquisition, generalization) go back.
**Prerequisites for tact programs**

- Articulation of the picture/tact is clear.
- Student should not make frequent errors on tacts.
- Student has at least 50 tacts
- Must have instructional control!

**Tact fluency video**
General guidelines

- Look for the fastest time.
- Does the student need to stand or sit?
- Also check to see what is fastest: if you point or if the student points.
- What field size? Start with the most successful. (never less than 4) start with 6 at minimum.
- Start with a 10 second sprint.

Probe baseline performance:
- Don’t say "what is it?" For every picture.
- Make sure responding is easy and student is successful.
- Run a minimum of three trials a day. Best to do so at least twice a day.
- Pick the best performance to graph.

Starting point

Set up tact fluency for the student: if they can tact a lot of pictures/items and it is understandable but they are not doing it at a fluent pace.

Differential reinforcement is important!

Make it fun! Like a game!
Reminders about reinforcement for fluency programs.

Use a promise reinforcer: have the best reinforcer out that the student loves! Say If you go really fast you will get the ___. (even if he doesn’t “understand”).

Use differential reinforcement

Evaluate the previous performances to determine the best times for delivery of reinforcement.

Did instructor determine a reinforcer that Student wanted at the moment?

Did instructor provide reinforcement for appropriate behaviors and appropriate responding?

Did instructor provide differential (better) reinforcement for specific behaviors targets for increase and for more independent responses? (the best score during fluency)

- Notes on ways to differentially reinforce:
  - More quantity of the reinforcer
  - Better quality
  - Larger magnitude
  - More time in contact with reinforcer

If Student engages in undesired behaviors or behaviors targeted for reduction, did instructor withhold reinforcement?
No matter how many times you practice you only convert the best score for the day and graph the best one.

Conversion to response per minute.

Example:

| 9 responses in 10 seconds converts to 9x6 to get the responses per minute. | Conversion for a 15 second timing: responses x4 | 20 second timing: responses x3 | 30 second timing: responses x2 |

Sample tact fluency graphs
Common errors

- Using the same pictures every time you run tact fluency
- Or rotating through 3 sets of pictures.
- Use any of the pictures in the card sort that are known. Don’t separate out for fluency only.
- Run a probe before doing the fluency session.
  - if the student errors on a tact, take that picture out of the array.
  - If the student has poor articulation for a tact, take it out of the array.
- If student points to a picture but says the one before or after... this is a procedural error that should be corrected.

Tact

Fluency program decisions

Decisions to make when an aim is hit:
- Do I increase the aim? (This is generally where to start for Tacts)
- Do I increase the field size?
- Do I build endurance and increase the timing sprint?
  - 10 seconds – 15 seconds – 20 seconds – 30 seconds – 1 minute?

When do we end a fluency program:
- When an aim is hit for 3 consecutive days.
- When the student can perform the skill with endurance
- When complex skills or composite skills are acquired easily.
When to consider Imitation fluency program

- Student should have at least 20-30 imitations acquired before looking at an imitation fluency program.
- If student has these difficulties: distractions, memorization issues, generalization issues, prompt dependency/spontaneous deficits.
- To teach multiple step imitation (2-3 sequenced).
- To build “generalized imitation”: imitate any novel movement.
Imitation probe

- video

Imitation fluency probe

general directions

- Make a poster with known imitation skills listed.
- Start with a 10 second sprint. With imitation you don’t say “do this” every time, warm up and make it a game.
- Tell him “I want you to go as fast as you can, get ready.”
- Start the timer when he gives his first response instead of when you give your first imitation.
- Be careful that you don’t go in the same order of imitation every time.
- You can repeat the imitation movements if needed.
Sample imitation fluency poster

Imitation fluency

• video
Set up imitation fluency for the student. 
(if they are all imitating pretty much anything (not 2-3 step imitations).

Differential reinforcement is important!

Example: I gave a small amount of reinforcement for the 5 responses, gave even more when he beat that number and got 8 then he got the most reinforcement for 9.

More considerations.

- moving faster than the student
  Don’t deliver the Sd before the student even imitates the last action.

- Only go as fast as the student.

Common errors
More on errors

Using imitations that require taking eyes off the instructor

“Do this” touch feet

Imitation fluency

- video
Imitation Fluency program decisions

Decisions to make when an aim is hit:
- Do I increase the aim?
- Do I increase the skills imitated?
- Do I build endurance and increase the timing sprint?
  - 10 seconds – 15 seconds– 20 seconds – 30 seconds – 1 minute?

When do we end a fluency program:
- When an aim is hit for 3 consecutive days.
- When the student can perform the skill with endurance (at least 30 seconds).
- When complex skills or composite skills are acquired easily.

Imitation fluency aim is 48-72 range.
If the student hits the aim for 3 days, then increase the timing not the aim
Keep the aim the same. For the aim, anything 48 responses per minute and higher is sufficient.
Make a big deal about hitting the aim! Or even just improving the responses.
End program when the student hits the aim for 3 consecutive days with a 30 second timing.
Data collection

No matter how many times you practice you only convert the best score for the day and graph the best one.

Conversion to response per minute.

Example:

<table>
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</table>

*Imitation to build articulation through improving sign.*

- video
When to consider echoic fluency

Articulation issues: In speech if the student can emit the sound of the item but not all of the time.

As a prerequisite for joint control programming. (2 words, 3 words, etc)

If student has difficulty such as distractions, memorization issues, generalization issues, prompt dependency/spontaneous behavior deficits.

Disclaimer: you must have instructional control with echoics.
Echoic fluency

• First teach echoic skill in Intensive teaching.
• When have a variety of echoics acquired in IT (50+ per sound).
• L-Sounds: baseline 64 L-words tested as echoics. Emitted less than 80% of the time in conversation.
• R-sounds: baseline 22 R-words as echoics. 39 R-words taught in Intensive teaching. A total of 61 R-words tested or taught. Emitted less than 80% of the time in conversation.
L-word fluency data.

Conversation with an adult: L-words
NET data: L-word (in Gen. Ed)

R-word Fluency data.
NET data in Gen. Ed: R-words

Conversation with Adult: R-words
Results

The student emitted sounds before fluency program in NET conversation less than 80% of the time. His articulation improved after the echoic fluency programs. He was able to emit the sounds more than 80% of the time in NET conversation after fluency instruction.

Fluency programming increased the rate of responding for the student and his articulation improved in conversation with L-words and R-words.

The articulation improved at a faster rate in the second program.

**Decisions to make when an aim is hit:**

- Do I increase the aim?
- Do I build endurance and increase the timing sprint?
- 10 seconds – 15 seconds – 20 seconds – 30 seconds – 1 minute?

**When do we end a fluency program:**

- When an aim is hit for 3 consecutive days.
- When the student can perform the skill in the NET
- When complex skills or composite skills are acquired easily.

**Echoic Fluency program decisions**
Listener Responding fluency

- If a student is easily distracted and slow to respond in Intensive teaching & articulation is poor, best to check this skill in NET teach tacts and check as an LR.
- Or if a student is easily distracted.
Listener responding


Teachers have found that when students achieve fluency in important prerequisite skills and knowledge they do not forget. Instead, more advanced work becomes easier rather than harder and learning becomes fun rather than tedious.
References


References.