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Journal of Precision Teaching and Celeration

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STATEMENT OF PURPOSE: As the official journal of the Standard Celeration Society, the Journal of Precision Teaching and Celeration has dedicated itself to a science of human behavior founded on a technology of direct, continuous and standard measurement. This measurement technology includes: a standard unit of behavior measurement – frequency; a standard measure of change in behavior frequencies – celeration; a standard measure of the variability of behavior frequencies – bounce; and a Standard Celeration Chart to display frequency, celeration and bounce data. The Standard Celeration Chart enables chart based statistical procedures to determine changes in frequency-frequency jumps, changes in celeration – celeration turns and changes in bounce – bounce verge.

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This book belongs to Michael Fabrizio. Please enjoy it thoroughly, treat it gently, and return it promptly.

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Kessissoglou and Farrell (1995) asked, "Whatever happened to precision teaching?" They noted that in the 1980s British journals witnessed several articles detailing Precision Teaching and its use in education. Speculating about the decline of published reports of Precision Teaching, Kessissoglou and Farrell surmise that either people no longer have interest in Precision Teaching or perhaps schools continue to use the method but do not publish results.

It would indeed seem a formidable task to investigate the use of Precision Teaching in other countries beside the United States of America where Precision Teaching remains active with the Journal of Precision Teaching and Celeration and publications in other mainstream journals (e.g., American Psychologist, Teaching Exceptional Children, Exceptional Children). Precision Teaching, however, does have a distinctive international presence and this issue serves as an indication of what others have accomplished outside the USA. Ken Kerr and Claire McDowell serve as guest editors and have six articles and one chart share showing how PT research and practice has occurred in Ireland. While the venue may differ from the United States, the Precision Teachers from Ireland show how the Standard Celeration Chart speaks a universal language when it comes to data. Volume 18, issue 2 also contains a commentary from the guest editors, a discussion article, and five additional chart shares.

REFERENCES
Guest Editors' Comments
Ken P. Kerr and Claire McDowell
Guest Editors

It is fitting that the current volume of the *Journal of Precision Teaching and Celeration* (JPTC) is prefaced by the recognition of the increasing interest in Precision Teaching (PT) in Ireland and the context in which it has been promoted. In an eloquent description of PT, John O. Cooper (1996) stated that “PT stimulates many questions and discoveries from students and teachers that result in rapid instructional change.... PT seems as if it is an uncultivated lovely WILD FLOWER” (p.4). Due recognition should be given as to how this “wild flower” has come to Ireland. Two professionals have helped create the environment wherein PT has flourished. John O. Cooper, who has provided numerous resources to help our development, and Mickey Keenan (University of Ulster) both deserve credit for cultivating, either directly or indirectly, all of the professionals who have contributed to this volume. We are thankful to both.

On reflecting upon our current stage of professional development we are pleased to say that PT has taken root in Ireland. The Saplings Model of Education (Co. Kildare) and Abalta (Galway) are two centres where PT is used in the education of children with autism. In addition, the University of Ulster is a central component in establishing PT in various areas of research. Further work, however, needs to be done to link “applied knowledge” with “experimental knowledge.” We will all benefit from this relationship.

To look forward is always a difficult endeavour. The metaphor as presented by Cooper (1996) of PT as a wild flower is useful, particularly his comment that one attribute of a wild flower is that it is not “aggressively competitive or invasive” (p.4). Current practitioners everywhere should reflect upon these attributes. In Ireland it has become commonplace for parents to resort to litigation in order to ensure appropriate (optimal) education for children with autism. We, therefore, more than others should be mindful of Cooper’s analogy. Marketing and communication of our product is of paramount importance. In a society where more than data is needed, we, as PT practitioners, need to develop a skill set to generate interest in our work (see Binder, 1996). Development of resources, such as instructional manuals including video footage in PT, along with specific publications in areas such as early intervention for children with autism are needed to sustain interest and foster growth. We look to the Standard Celeration Society to help provide the necessary environmental support. We also recognise that we have a personal responsibility to share our knowledge base and a professional responsibility to learn more from established practitioners so that PT will continue to grow.

For now, we are proud of our contribution to the PT literature. Smyth and Keenan consider how controlling the number of practice opportunities on component skills will affect compound skill acquisition and performance. McDowell and Keenan also consider teaching sequences using component-compound analysis. McDowell, Keenan, and Kerr compare levels of dysfluency on three tasks between students with Mild Learning Disabilities and typical students. In terms of sporting skill acquisition and maintenance, McDowell, McIntyre, Bones, and Keenan use PT to systematically improve the golf swing through fluency tuition. Cobane and Keenan focus on how specific practice affects positive and negative inners experienced by an elderly person throughout the day. Finally, Kerr, Campbell, and McCrory introduce The Saplings Model of Education and present learning pictures from three children in advocating for the use of PT with children with autism. The inclusion of a chart share also marks our commitment to presenting work in progress. It is hoped that the reader enjoys our contribution to the PT community and we look forward to establishing greater links in the future.

REFERENCES


Compound Performance: The Role of Free and Controlled Operant Components*
Philomena Smyth and Michael Keenan
University of Ulster at Coleraine

Precision Teaching methodology promotes fluency building in component behaviors in order to impact on the performance of compound behaviors. A review of the literature suggests that component behaviors must attain a certain frequency of performance before they can easily coalesce into a behavioral compound. The purpose of this experiment was to examine performance on the compound behavior when one component was taught to a preset fluency aim range under free operant conditions and a second component was taught under controlled operant conditions, through pacing. Results indicate that compound performance was improved when tested with one component at the fluency aim range and the second component at the paced controlled operant criteria.

DESCRIPTORS: Component, compound, free operant, controlled operant, momentum

Precision Teaching methodology has a long history of building component skills to fluency in order to impact upon the acquisition and performance of compound behaviors (Binder, 1993; 1996). Research has shown that building component skills to high frequencies can sufficiently impact upon a subsequent compound skill to increase its performance to a fluent level without ever delivering instruction on that skill (McDowell, 2001). Generally, fluency, in the form of increased performance frequencies, is required to facilitate the easy combining of component behaviors into a behavioral compound. Data published by Barrett (1979, cited in Johnson & Layng, 1992) shows how normal functioning adults can perform the compound skill of writing the number 4 at an average rate of 100 per minute. This is roughly half the rate of performance on the component skill of writing the number 1, which was performed at the average rate of 210 per minute. However it remains unclear if all components of a compound skill must be fluent before they can combine to produce a compound behavior.

Lindsley (1997) suggests that fluency may be related to the area of behavioral momentum. Behavioral momentum is comprised of two main elements, behavioral "velocity" and "behavioral mass." These two elements provide the links to the Precision Teaching framework. Behavioral velocity refers to rate or frequency of response. Behavioral mass refers to an established frequency's resistance to change when responding is challenged. The fluency products of "Retention", "Endurance" and "Application" also refer to resistance to change when performance is challenged by a period of non-practice. Endurance refers to resistance to change when performance is challenged by longer performance periods. And finally Application refers to resistance to change when performance is challenged by more complex requirements.

The links between Precision Teaching and the Behavioral Momentum framework provide the basis for an examination of the role of free-operant fluent components and controlled non-fluent components on the acquisition and performance of a related compound behavior. Higher rates of performance are associated with Application, Retention and Endurance, however research within the Precision Teaching framework has found that the highest rates of performance are not necessarily associated with subsequent progression on skills (Evans & Evans, 1985). Rather an optimal rate of performance may exist that allows a greater resistance to change. This rate may be deemed a Fluency rate. Conversely, within the Behavioral Momentum framework, Nevin (2001) states that lower performance rates are more resistant to change than higher performance rates, when reinforcement rates are equal. The purpose of this experiment was to examine compound behavior when 2 component skills are taught under differing conditions, one free operant and one controlled operant in the form of paced responding. A compound task was examined to establish if component skills performed at different rates relative to their Fluency Aim Range can coalesce into a compound behavior, and if so does that compound behavior display resistance to change in terms of Retention and Endurance.

*This study was supported by a research grant from Louth County Council, Republic of Ireland.
METHOD

Participants and Setting

Five school children, two girls and three boys, were participants in this experiment. Ashley, Bronagh, Gary, Shane and Tony were all seven years old at the beginning of the experiment. All five participants were students at a primary school in Northern Ireland. The students were selected for participation in the experiment on the basis of teacher assessment. Their teacher identified each of the students as experiencing some level of difficulty with reading tasks. The sessions were conducted in a vacant classroom of the primary school.

Tasks

Each learner completed practice on two component reading skills and one compound reading skill; Component skill 1: practice see/say consonant-vowel blends. Component skill 2: practice see/say consonant-consonant blends. Compound skill: practice see/say words that contained consonant-vowel-consonant-consonant blends.

Phases and Conditions

There were five different phases during the experiment: Phase 1 involved the collection of baseline data on the two component skills and the compound skill. Phase 2 comprised of two separate conditions, Condition 1 was a paced condition. In order to respond to the visual stimulus the student had to wait until an auditory stimulus was heard. Responding to the next visual stimulus was contingent upon hearing the next auditory stimulus. Condition 2 was a free-operant condition where the all the visual stimuli were presented together. The student was free to respond to the material at his or her own pace, no auditory stimulus was present. In this Phase students received instruction on both component skills. During practice one component skill was practiced under free-operant conditions, the second component skill was practiced under paced responding conditions. The components practiced under free and paced conditions were randomly alternated between students. During this phase performance was reinforced through the use of a token economy, where 10 tokens could be exchanged for a choice of 1 item from a selection of small toys, novelty stationary items and edibles. Reinforcement was contingent upon attaining a preset aim. In Phase 3 the compound skill was tested under baseline conditions, and checked for retention and endurance. In Phase 4 the student practiced the previously paced component skill under free operant conditions. During this phase performance was reinforced in the same manner as in Phase 2. In Phase 5 the compound skill was tested under baseline conditions, and checked for retention and endurance.

Timings

Three timing periods were used throughout the practice sessions, 30 seconds, 1 minute and 3 minutes. 30-second timings were used only when data indicated that a student had difficulty performing a task for 1 minute. A 1-minute timing period was used as a standard performance period throughout the practice sessions. 3-minute timing periods were used to check for endurance of performance on the compound task.

PROCEDURE

Sessions

Baseline data collection and intervention sessions (Phases 1-5) were conducted on a number of days each week that suited the schools timetable. Sessions were occasionally cancelled due to school activities.

Phase 1: Baseline. In this phase, stimuli were presented under free operant conditions. Stimuli were presented on cards that were placed in random order on the tabletop. For see/say consonant-vowel combinations a total of 26 different combinations were presented. The 26 combinations were repeated 2 times in random order (52 cards in total). For see/say consonant-consonant combinations 14 different combinations were presented, repeated 3 times randomly (a total of 42 cards). For see/say words 31 different words were presented, repeated 2 times randomly (a total of 62 cards). Before the timing began the student was given the following instructions: "I am going to point to a card, this card is your starting point. When you are ready I want you to say what you see on the card, and move on to the next one and so on. If you come to the end of the cards I want you to return to the start and continue saying what you see on the cards." Starting points were chosen at random. The timing began once the student responded to the first card. All baseline timings were of a 1-minute duration. Students received only one timing opportunity during a baseline session. The number of correct and incorrect responses were counted, the student received no feedback or instruction at this point. Baseline data collection ended when the students' rate of responding showed little or no change.

Phase 2: Paced and Free Operant Responding.

Condition 1 - Paced Responding: In this condition stimuli were again presented on cards placed...
in random order on the tabletop. The same number of cards were presented, and repeated, as in Phase 1. Before a timing began the student was given the following instructions: "I am going to point to a card; this card is your starting point. When you hear the beep I want you to say what you see on the card, this card is your starting point. When you are ready I want you to try to get through as many cards as you can. Again starting points were chosen at random. Timings in this condition were either 30-seconds or 1-minute in duration, depending on the performance of the student. Students received repeated timing opportunities during a free operant session. At the end of the timing the number of correct and incorrect responses were counted and the student received feedback and instruction. Free operant conditions ended when the student had responded at a preset Fluency Aim Range (F.A.R.) for three days (F.A.R was set at 40-45, half of the component skills F.A.R., or Fluency Aim Range of 80-100). Condition 2 - Free Operant Responding: As in Phase 1, stimuli were presented on cards placed in random order on the desktop. The same number of cards were presented, and repeated. Before the timing began the student was given the following instructions: "I am going to point to a card, this card is your starting point. When you are ready I want you to try to get through as many cards as you can.

Phase 3: Testing, Retention and Endurance. Performance, retention and endurance on the compound skill were tested under baseline conditions. Stimuli were arranged in the same manner and similar instructions were delivered. Testing of performance on the compound skill ended when the student's performance showed little or no change for three days. At this point the student received no practice opportunities on the task for at least 1 week in order to check for retention. However due to the applied nature of the experiment some no practice periods were longer than 1-week. During the endurance check instructions varied slightly from those delivered during baseline, the performance test and the retention check. At this point students were informed that the performance period would be 3-minutes. As in all conditions, the number of correct and incorrect responses were counted at the end of all timings. The student received no feedback or instruction at this time.

Phase 4: Free Operant Practice on Previously Controlled Component. In this phase the procedure followed the same format as in Phase 2, Condition 2.

Phase 5: Testing, Retention and Endurance. In this phase the procedure followed the same format as in Phase 3.

RESULTS

Table 4 displays the Phase 1 rate of responding for each learner during a 1-minute timing on the component skills see/say consonant – vowel blends and see/say consonant – consonant blends and the compound skill see/say words. Skills were practiced under baseline conditions during this phase. It can be seen from table 1 that responding for all learners was well below the Fluency Aim Range on all skills, with a variable degree of error occurring. Baseline rates of responding for each learner are shown in Phase 1 on Figures 1 to 5.

Table 5 displays the Phase 2 rates of responding for each learner on the component skills see/say consonant – vowel blends and see/say consonant - consonant blends. In this phase the learners practiced both skills. However for each learner one skill was practiced under free conditions and the other under paced conditions. It can be seen from table 2 that all learners reached both the Fluency Aim Range and the Paced Aim Range for three days (P.A.R. was set at 40-45, half of the component skills F.A.R., or Fluency Aim Range of 80-100).

Table 6 displays the Phase 3 rate of responding for each learner on the compound task see/say words under baseline conditions. In this phase the compound task was assessed during a 1-minute timing, and checked for Retention and Endurance. It can be seen from table 3 that the rate of responding for all learners had improved from...
### Table 1
Phase 1 baseline performance ranges on component skills and compound task during a 1 minute timing

<table>
<thead>
<tr>
<th>Learner</th>
<th>Correct</th>
<th>Incorrect</th>
<th>Sessions to stability</th>
<th>See /Say consonant-vowel blends</th>
<th>See /Say consonant-consonant blends</th>
<th>See /Say words</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ashley</td>
<td>8-21</td>
<td>13-1</td>
<td>5</td>
<td>11-13</td>
<td>11-14</td>
<td>5-14</td>
</tr>
<tr>
<td>Bronagh</td>
<td>15-23</td>
<td>5-9</td>
<td>6</td>
<td>8-10</td>
<td>8-12</td>
<td>19-28</td>
</tr>
<tr>
<td>Gary</td>
<td>9-18</td>
<td>4-12</td>
<td>6</td>
<td>4-8</td>
<td>9-18</td>
<td>19-22</td>
</tr>
<tr>
<td>Shane</td>
<td>26-31</td>
<td>2-3</td>
<td>4</td>
<td>18-22</td>
<td>1-6</td>
<td>9-13</td>
</tr>
<tr>
<td>Tony</td>
<td>14-17</td>
<td>5-9</td>
<td>4</td>
<td>14-17</td>
<td>5-10</td>
<td>4-10</td>
</tr>
</tbody>
</table>

### Table 2
Phase 2 performance ranges on component skills see /say consonant – vowel blends and see /say consonant – consonant blends

<table>
<thead>
<tr>
<th>Learner</th>
<th>Condition</th>
<th>Aim</th>
<th>Timing Durations</th>
<th>Correct Score Range</th>
<th>Incorrect Score Range</th>
<th>Sessions to Aim</th>
<th>Initial Correct Collocation</th>
<th>See /Say consonant-vowel blends</th>
<th>See /Say consonant-consonant blends</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ashley</td>
<td>Free</td>
<td>80 - 100</td>
<td>30 seconds 1 Minute</td>
<td>47-93</td>
<td>0-4</td>
<td>12</td>
<td>X3</td>
<td>Paced</td>
<td>40 - 45</td>
</tr>
<tr>
<td>Bronagh</td>
<td>Free</td>
<td>80 - 100</td>
<td>1 Minute</td>
<td>52-96</td>
<td>0-10</td>
<td>6</td>
<td>X4</td>
<td>Paced</td>
<td>40 - 45</td>
</tr>
<tr>
<td>Gary</td>
<td>Free</td>
<td>80 - 100</td>
<td>1 Minute</td>
<td>66-83</td>
<td>0-3</td>
<td>4</td>
<td>X3</td>
<td>Paced</td>
<td>40 - 45</td>
</tr>
<tr>
<td>Shane</td>
<td>Paed</td>
<td>40 - 45</td>
<td>1 Minute</td>
<td>40-42</td>
<td>0-1</td>
<td>4</td>
<td>__</td>
<td>Free</td>
<td>80 - 100</td>
</tr>
<tr>
<td>Tony</td>
<td>Paed</td>
<td>40 - 45</td>
<td>1 Minute</td>
<td>42-45</td>
<td>0</td>
<td>3</td>
<td>__</td>
<td>Free</td>
<td>80 - 100</td>
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</tbody>
</table>
Phase 1. It can also be seen from Table 3 that all learners displayed a good degree of retention and endurance relative to the 1-minute assessment. Each learner's rate of responding on the compound task can be seen in Figures 1 to 5, Phase 3.

Table 4 displays the Phase 4 rate of responding for each learner on a previously paced component skill, now practiced under free conditions.

It can be seen from Table 4 that all learners achieved F.A.R. rate of responding. Each learner's rate of responding on a previously controlled component skill is seen in Figures 1 to 5, Phase 4.

Table 5 displays the Phase 5 rate of responding for each learner on the compound task see/say words under baseline conditions. In this phase the compound task was assessed during a 1 minute timing, and checked for Retention and Endurance.

It can be seen from Table 5 that the rate of responding for all learners had improved from Phase 3. It can also be seen from Table 5 that all learners displayed a good degree of retention and endurance relative to the 1-minute assessment. Each learner's rate of responding on the compound skill can be seen in Figures 1 to 5, Phase 5.

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Table 3

<table>
<thead>
<tr>
<th>Learner</th>
<th>Baseline</th>
<th>Phase 1</th>
<th>Correct-Score</th>
<th>Duration Used</th>
<th>Correct-Score</th>
<th>High</th>
<th>Score Range</th>
<th>Duration Used</th>
<th>Initial Correct</th>
<th>Duration Used</th>
<th>Timing Durations</th>
<th>Correct-Score</th>
<th>Minutes</th>
<th>Endurance Check</th>
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<tr>
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<td>Baseline</td>
<td>14</td>
<td>1</td>
<td>41</td>
<td>1-3</td>
<td>5</td>
<td>X: 3</td>
<td>1</td>
<td>40</td>
<td>3 Minutes</td>
<td>39</td>
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<tr>
<td>Bronagh</td>
<td>Baseline</td>
<td>28</td>
<td>1</td>
<td>62</td>
<td>2-3</td>
<td>5</td>
<td>X: 1.3</td>
<td>1</td>
<td>72</td>
<td>3 Minutes</td>
<td>71</td>
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<td>62</td>
<td>1-5</td>
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<td>51</td>
<td>3 Minutes</td>
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<td>Baseline</td>
<td>13</td>
<td>1</td>
<td>44</td>
<td>2-5</td>
<td>5</td>
<td>X: 1.8</td>
<td>1</td>
<td>36</td>
<td>3 Minutes</td>
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<td>43</td>
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<table>
<thead>
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<th>Component Skill</th>
<th>Phase 2 Condition</th>
<th>Phase 2 Aim</th>
<th>Phase 4 Condition</th>
<th>Phase 4 Aim</th>
<th>Timing Durations Used</th>
<th>Sessions to Aim</th>
<th>Initial Correct Celeration</th>
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Table 5

Phase 5 performance ranges on the compound task see/say words

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**DISCUSSION**

The purpose of this experiment was to examine the acquisition and performance of a compound task when components were taught under different conditions, free-operant and controlled-operant (paced). The results show that performance on the compound skill was improved for all participants, relative to previous performance, when 1 component skill was performed at the free operant Fluency Aim Range (F.A.R.) and the second component was performed at the controlled operant Paced Aim Range (P.A.R.). However, results also demonstrate that compound performance was further facilitated when both components were performed at the F.A.R.

The average correct performance high for all students during baseline, when both components were not fluent, was 87 responses per minute. When 1 component was performed at the F.A.R. and the other at the P.A.R., average correct performance for all learners was 251 responses per minute. This represents an average increase of x2.9 between compound performance at Phase 1 and Phase 3. In addition to this all students, with the exception of Shane, retained this rate of performance after a period of non-practice. Endurance checks showed that the compound task could be performed for longer periods of time with only 1 component at the F.A.R. However, no student reached the F.A.R. on the compound task with only 1 component fluent.

The rate of correct responding on the compound task improved yet again for all students when performance on the second component was brought to the F.A.R. The average correct performance high for all students on the compound task, with both components at the F.A.R., was 334 responses per minute. This represents an average increase of x 1.3 between
compound performance at Phase 3 and Phase 5. Retention checks showed that all students retained this rate of performance after a period of non-practice. Checks for endurance showed that compound performance could endure for longer periods when both components are performed at the F.A.R. Two students reached the F.A.R. without any intervention when both components were performed at the F.A.R. Brongah's performance on the compound task reached 91 correct responses per minute. Gary's performance on the compound task reached 87 correct responses per minute. Of interest is the fact that in Phase 2 of the experiment the performance of both of these students was controlled on the see/say consonant-consonant blends component. Of the students whose performance was controlled on the component see/say consonant-vowel blends in Phase 2 of the experiment, none reached the F.A.R on the compound task in Phase 5.

The results of this experiment confirm the findings of McDowell (2001) who found that building component skills to fluency can increase rate of performance on a compound skill to a fluent level without having to deliver instruction on that skill. In addition to this the results support the methodological practice of increasing frequencies in component skills in order to enhance performance on compound skills. Of interest is the fact that when only one component was performed at the F.A.R, with the second being performed at the P.A.R., almost all students performed the compound task at roughly half the rate of the F.A.R. This is similar to the finding of Barrett (1979), cited in Johnson & Layng, 1992 where compound skills are performed at roughly half the rate of the fluent component skill. Based on this similarity in findings it would appear that bringing 1 component (from a choice of 2) to a fluency level facilitates compound skill acquisition and performance. This may be due to a momentum effect in the component at the F.A.R. that compensates for a non-fluent component and therefore facilitates compound performance. In addition to this it appears that performance on a compound task in which all components are not fluent can still display resistance to change in terms of retention and endurance.

The results of this experiment raise questions as to whether all components of a compound skill need to be taught to fluency or if perhaps certain components play a greater role in compound acquisition and performance. Research is needed to establish if these effects hold when a compound task is constructed from more than 2 components. The findings of the experiment also have important implications in the planning and implementation of curriculums. This is particularly so for students who are lagging behind their peers in the educational process and are playing a game of "catch-up." If certain components are more important in the acquisition of compound skills, the challenge to all educators is to identify which ones.

REFERENCES


Figure 3
Figure 5

Successive Calendar Days (by weeks)
Comparison of two teaching structures examining the effects of component fluency on the performance of related skills

Claire McDowell and Michael Keenan
University of Ulster at Coleraine

This experiment compared two teaching structures to assess the effects of component skill fluency on the acquisition of more complex tasks. A multiple baseline across tasks design was used to assess the effects that teaching a component skill to fluency had on rates of responding on a second component skill and a compound task (Condition 1), and the effects that teaching a compound task to fluency had on rate of responding on 2 component skills (Condition 2). The results show that learners in Group 1, taught under Condition 1 made better overall progress on the three tasks than learners in Group 2 taught under Condition 2. Group 1 learners not only reached fluency aim on all tasks, but did so with fewer teaching sessions, with some participants achieving fluency aim under baseline conditions with no direct intervention at all. Learners in Group 2 required more sessions to reach fluency aim on tasks under intervention and two learners did not achieve aim on the two component skills.

DESCRIPTORS: Fluency, compound behaviors, component skills

Precision teachers stress the key role fluency plays in learning, stating that cumulative dysfluency (the accumulation of dysfluent component skills) may be the most important factor in long-term student failure (Binder, 1996). They assert that in order to facilitate learner’s progression through the curriculum, teachers should insure that tasks are analysed to determine prerequisite behaviours and component skills. Learner’s performances on these skills can then be tested and they can subsequently be placed appropriately within the curriculum structure (Resnick, 1967; Resnick & Wang, 1969; Resnick, Wang & Kaplan, 1973; Sulzer-Azaroff & Mayer, 1991). Once taught, fluent components skills then combine to generate new composite skills with little or no formal instruction (Johnson & Layng, 1992).

Early laboratory studies using animals demonstrated that trained behaviours combined to produce new, more complex behaviours that had not been directly trained (Andronis, Goldiamond & Layng, 1983). Lutzer and Sherman (1974) observed novel, untrained sentence usage by children with learning disabilities when sentence components were trained. Johnson and Layng (1994) have observed the generative effects of fluent components in all areas of the curriculum, including language, writing and math skills. This experiment used a multiple baseline across tasks to examine the effects of two teaching structures on skill performance. It used the design to examine whether an intervention designed to increase learners’ rates of responding on a compound task resulted in increased rates of responding on two components skills of this task. Normally, multiple baseline designs are used to show that changes only occur in the behaviour under intervention. In this case the design was utilised to examine whether change in rate of responding would occur in the two tasks not under intervention as a result of increased fluency in the task under intervention.

METHOD

Design
A multiple baseline across tasks design was used to assess the effects of the two teaching structures on component skill and compound task performance.

Participants and Setting
Seven primary school children (five males and two females) participated in this experiment. All had been diagnosed by educational psychologists as having mild learning difficulties (MLD). Six of the children attended a school for children with special educational needs and one child (Learner P) attended main stream primary school where he attended remedial classes for math and reading. For six of the participants, teaching and testing sessions were conducted in a small room off their main classroom. For Learner P, sessions were conducted in a quiet room at his home.

Tasks
All the children had been identified by teachers or parents as having difficulty learning and performing particular tasks in the curriculum,
RESULTS

Figure 2 shows learner P’s rate of responding on all tasks under Condition 1. The top panel shows rate of responding on Component Skill 1 and Group 2 participants’ baseline (70-90 digits per min.) was achieved in 6 teaching sessions. Intervention resulted in fluency aim (70-90 digits per min.) being achieved in 16 teaching sessions. Rate of responding accelerated at x1.1 under intervention. The middle panel shows Learner M’s rate of responding on the Compound Task under baseline and intervention. Under baseline conditions, rate of responding increased from 25 correct responses per min. to 61 correct responses per min., a learning acceleration of x1.15. When fluency aim was achieved and maintained for 3 sessions, teaching began on the final component skill or compound task. Again, performance on the remaining skill not under intervention was tested during each session. When fluency aim was achieved and maintained for 3 sessions, teaching began on the final component skill or compound task.

Figure 3 shows learner P’s rate of responding on all tasks under Condition 1. The top panel shows rate of responding on Component Skill 1 under baseline and intervention conditions. Intervention resulted in 3 consecutive sessions teaching began on the next component skill or compound task. Again, performance on the remaining skill not under intervention was tested during each session. When fluency aim was achieved and maintained for 3 sessions, teaching began on the final component skill or compound task.

PROCEDURE

Figure 1 shows the procedure followed in this experiment. Intervention. Participants were taught separately and each attended two thirty-minute sessions per week. During teaching sessions participants received instruction, practice, error correction, and feedback on the particular component skill or compound task under intervention. They were then asked to perform the task for several 1-minute timings and the best score of the session was recorded. Performance was reinforced using a token economy where 10 stickers could be exchanged for 1 item chosen from a range of edibles and small toys. Reinforcement was contingent upon reaching a daily aim, set at the beginning of the session, for the task under intervention.

Testing. At some point during the session, the participants performance on the remaining Component skills (Group 2) or the remaining Component Skill and Compound Task (Group 1) were tested during a 1-min. timing. During the testing period no instruction or feedback was given. Testing was carried out either before teaching on the target skill, or after it had taken place. The order in which skills were taught or tested was alternated across sessions for all participants to control for practice effects. As each participant reached fluent performance on the task under intervention and maintained it for 3 consecutive sessions teaching began on the next component skill or compound task. Again, performance on the remaining skill not under intervention was tested during each session. When fluency aim was achieved and maintained for 3 sessions, teaching began on the final component skill or compound task.

RESULTS

Group 1 and Group 2 participants’ baseline rates of responding, accelerations and number of teaching sessions to fluency aim for the component skills and compound tasks are shown in Table 1. Each learner’s rate of responding on 2 component skills and one compound tasks are shown on Figures 2 – 7.

Group 1 (Condition 1). Math Tasks. Figure 2 shows learner M’s rate of responding on all tasks under Condition 1. The top panel shows rate of responding on Component Skill 1 under baseline and intervention conditions. Intervention resulted in 3 consecutive sessions at fluency aim (60-80 dots per minute) being achieved in 16 teaching sessions. Rate of responding accelerated at x1.1 under intervention. The middle panel shows Learner M’s rate of responding on Component Skill 2 under baseline and intervention. Under baseline conditions, rate of responding increased from 13 correct responses per minute to 38 correct responses per min., a learning acceleration of x1.15. Intervention resulted in fluency aim (70-90 dots per min.) being achieved in 12 teaching sessions. The bottom panel shows learner M’s rate of responding on the Compound Task under baseline and intervention conditions. Under baseline conditions, rate of responding increased from 25 correct responses per min. to 61 correct responses per min., a learning acceleration of x1.1. Fluency aim (70-90 digits per min.) was achieved in 6 teaching sessions.

Figure 3 shows learner P’s rate of responding on all tasks under Condition 1. The top panel shows rate of responding on Component Skill 1 under baseline and intervention conditions. Intervention resulted in 3 consecutive sessions at fluency aim (60-80 dots per min.) being achieved in 16 teaching sessions.
Figure 1

All participants (MLD) selected based on teacher concerns

Participants randomly allocated to Group 1 or Group 2

Group 1

Component skill 1 taught to fluency aim (performance on compound task and component skill 2 tested throughout)

Component skill 2 taught to fluency aim (performance on compound task tested throughout)

Compound task taught to fluency aim

Group 2

Compound task taught to fluency aim (performance on component skills 1 and 2 tested throughout)

Component skill 2 taught to fluency aim (performance on component skill 1 tested throughout)

Component skill 1 taught to fluency aim
consecutive sessions at fluency aim (60-80 dots per min.) being achieved in 13 teaching sessions. Rate of responding accelerated at x1.15 under intervention. The middle panel shows learner P's rate of responding on Component Skill 1 under baseline and intervention conditions. Under baseline conditions, rate of responding increased from 24 correct responses per min. to 41 correct responses per min., a learning celeration of x1.15. Intervention resulted in fluency aim (70-90 digits per min.) being achieved in 11 teaching sessions. The bottom panel shows learner P's rate of responding on the Compound Task under baseline and intervention conditions. Under baseline conditions, rate of responding increased from 14 correct responses per min. to 75 correct responses per min., a learning celeration of x1.2. Fluency aim was not reached. The middle panel shows learner P's rate of responding on the Compound Task under baseline and intervention conditions. Under baseline conditions, rate of responding increased from 14 correct responses per min. to 75 correct responses per min., a learning celeration of x1.2. Fluency aim (40-50 responses per min.) was achieved in 3 teaching sessions.

Group 2 (Condition 2) Math Tasks. Figure 5 shows learner E's rate of responding on all tasks under Condition 1. The top panel shows rate of responding on Component Skill 1 under baseline and intervention conditions. Intervention resulted in 3 consecutive sessions at fluency aim (60-80 dots per min.) being achieved in 2 teaching sessions. The bottom panel shows learner E's rate of responding on the Compound Task under baseline and intervention conditions. Under baseline conditions, rate of responding increased from 16 correct responses per min. to 66 correct responses per min., a learning celeration of x1.1. Intervention resulted in fluency aim (60-80 responses per min.) being achieved in 5 teaching sessions. The bottom panel shows learner E's rate of responding on the Compound Task under baseline and intervention conditions. Under baseline conditions, rate of responding increased from 8 correct responses per min. to 39 correct responses per min., a learning celeration of x1.2. Fluency aim (40-50 responses per min.) was achieved in 3 teaching sessions. Group 2 (Condition 2) Math Tasks. Figure 6 shows learner L's rate of responding on all tasks under Condition 2. The top panel shows rate of responding on the Compound task. Intervention resulted in fluency aim (70-90 digits per min.) being achieved after 19 teaching sessions, a learning celeration of x1.1. The middle panel shows L's rate of responding on Component Skill 2. Under baseline conditions, rate of responding increased from 3 correct responses per min. to 37 correct responses per min., a learning celeration of x1.05. However, despite 8 sessions under intervention, fluency aim was not achieved. The bottom panel shows rate of responding on Component Skill 1. Under baseline conditions, rates of responding increased from 22 correct responses per min. to 85 correct responses per min., a learning celeration of x1.15. Fluency aim (40-50 responses per min.) was achieved under baseline conditions.

Figure 7 shows learner C's rate of responding on all tasks under Condition 2. The top panel shows rate of responding on the Compound task. Intervention resulted in fluency aim (70-90 digits per min.) being achieved over 3 sessions after 33 teaching sessions, a learning celeration of x1.1. The middle panel shows C's rate of responding on Component Skill 2. Under baseline conditions, rate of responding increased from 19 correct responses per min. to 34 correct responses per min., a learning celeration of x1.1. Fluency aim was not achieved. The bottom panel shows rate of responding on Component Skill 1. Under baseline conditions, rates of responding increased from 9 correct responses per min. to 23 correct responses per min., a learning celeration of x1. Again, due to time constraints no intervention took place therefore fluency aim was not reached. Group 2 (Condition 3) Reading Tasks. Figure 8 shows Learner J's rate of responding on all tasks under Condition 2. The top panel shows rate of responding on the Compound task. Intervention resulted in fluency aim (40-50 responses per min.) being achieved over 3 sessions after 28 teaching sessions, a learning celeration of x1.2. The middle panel shows C's rate of responding on Component Skill 2. Under baseline conditions, rate of
## Math Tasks

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<tr>
<td><strong>Aim achieved</strong></td>
<td>22 teaching sessions</td>
<td>2 teaching sessions</td>
<td>Achieved in baseline</td>
</tr>
<tr>
<td><strong>Celeration</strong></td>
<td>X 1.1</td>
<td>X 1.1</td>
<td>X 1.15</td>
</tr>
<tr>
<td><strong>Learner E (Group 1)</strong></td>
<td>Component Skill 1</td>
<td>Component Skill 2</td>
<td>Compound Task</td>
</tr>
<tr>
<td><strong>Baseline</strong></td>
<td>26/6 26/6</td>
<td>9/1 16/3</td>
<td>6/4 8/5</td>
</tr>
<tr>
<td><strong>Aim achieved</strong></td>
<td>10 teaching sessions</td>
<td>Aim reached in baseline</td>
<td>3 teaching sessions</td>
</tr>
<tr>
<td><strong>Celeration</strong></td>
<td>X 1.1</td>
<td>X 1.4</td>
<td>X 1.2</td>
</tr>
<tr>
<td><strong>Learner J (Group 2)</strong></td>
<td>Compound Task</td>
<td>Component Skill 2</td>
<td>Component Skill 1</td>
</tr>
<tr>
<td><strong>Baseline</strong></td>
<td>7/4 6/5</td>
<td>3/4 4/5</td>
<td>22/5 34/4</td>
</tr>
<tr>
<td><strong>Aim achieved</strong></td>
<td>25 teaching sessions</td>
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<tr>
<td><strong>Celeration</strong></td>
<td>X 1.2</td>
<td>X 1.1</td>
<td>X 1.1</td>
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The results for both groups seem to indicate that the purpose of this experiment was to investigate the effects that two different teaching structures would have on learners' performance of component skills and related compound tasks. The results from both groups of learners clearly show differences in the acquisition of skills under Condition 1 (Component 1, Component 2, Compound Task) generally make greater progress across all 3 tasks than Group 2 participants taught under Condition 2.

Both participants in Group 1 (Condition 1) who performed math tasks reached aim on all 3 tasks with fewer teaching sessions than Group 2 participants who performed these tasks. Learner P achieved aim on the Compound Task without any direct teaching. Learner L (Group 2) required more teaching sessions to reach aim on the Compound Task than either Group 1 participants, and did not reach aim on Component Skill 1. Learner C (Group 2) required more teaching sessions than either of the Group 1 participants to reach aim on the Compound Task and did not reach aim on either Component Skill 1 or 2. Learning celerations were generally higher across tasks for Group 1 participants (Mean x1.17) than Group 2 participants (Mean x1.05).

One unexpected finding was that learner L reached fluency aim on Component Skill 1 under baseline conditions. Learning on this task accelerated at x 1.1 without any direct teaching. This effect was not observed in any other Group 2 participants' performance on component skills. One explanation for this finding may lie in the nature of the task itself – see/dot multiples of 2 on a number grid. The practice effect of completing the task during the testing phase of each session may have been enough to allow performance to become fluent. While the effects of achieving fluency aim on the Compound Task may have had some influence on this learner's performance of Component Skill 1, the fact that learner L did not reach fluency aim on Component Skill 2 indicates that fluency in performance of the Compound Task did not have the same effect on the performance of all the components of this task.

Both Group 1 (Condition 1) participants completing reading tasks achieved aim on all tasks with fewer teaching sessions than the Group 2 (Condition 2) participant. Both Group 1 learners reached aim on one task without any direct teaching. Learner J (Group 2) required more sessions under intervention to reach aim on the Compound Task and did not reach aim on either Component Skill 1 or Component Skill 2. Learning celerations on all tasks were generally higher across tasks for group 1 participants (Mean x 1.17) than Group 2 (Mean x 1.1).

While it is impossible to control for all variables when conducting research in applied settings, there are two areas of concern when interpreting these results relating to a possible weakness in the design of this experiment. The repeated exposure to task materials allowed learners many opportunities to perform each task. This would not doubt have resulted in practice effects influencing all participants' performances over time. As stated earlier, practice effects played a role in learner L's performance of Component Skill 1 as she reached fluency aim under baseline conditions. However, the fact that participants in Group 2 did not reach fluency aim on several tasks, and generally had lower learning celerations across tasks rules out the fact the practice effects alone can account for all progress made on tasks.

A second area of concern is that the instruction and practice learners received in their normal classroom setting on a daily basis may have had some effect on their performance of these skills. Again however, the fact that participants in Group 2, performing under Condition 2 did not reach fluency aim on several tasks, and had lower learning celerations across tasks indicates that classroom activities did not play a crucial role in performance.

The results for both groups seem to indicate that those participants who were taught each component skill in succession before moving on to a higher-level skill made better progress. They generally required less teaching to achieve fluency aim as they progressed through the programme. On three occasions, aims were achieved without any teaching at all. Learning celerations were higher as a result of less time being required to acquire these skills. Conversely, Group 2 participants required more teaching to reach fluency aims, or did not reach fluency at all in the course of the experiment. Learning celerations were generally lower as more time was required to acquire each skill.

Practice effects aside, these results strongly
Figure 5

Baseline | Intervention

| Sessions |

- EM range at 1.1
- EM range at 1.4
- EM range at 1.2
- Record floor
- Testing
Figure 6
<table>
<thead>
<tr>
<th>Sessions</th>
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<th>Intervention</th>
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<tr>
<td></td>
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<td>sim range</td>
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<tr>
<td></td>
<td>x 1.2</td>
<td>x 1.1</td>
</tr>
<tr>
<td></td>
<td>4 lines</td>
<td>5 lines, 6 lines, all lines</td>
</tr>
<tr>
<td></td>
<td>record floor</td>
<td>record floor</td>
</tr>
<tr>
<td></td>
<td>testing</td>
<td>testing</td>
</tr>
</tbody>
</table>

Figure 8
suggest that fluent component skills have a major impact on learning the higher skills that depend on them. It would appear from this sample of learners that ensuring component skills are taught to fluency eases the acquisition of more complex skills, with some skills being acquired with little or no teaching at all. Oppositely, teaching compound tasks to fluency does not ensure that the learner will be able to perform the components of that skill fluently. These findings support previous evidence highlighting the importance of appropriate curriculum placement. It would appear that simply teaching a composite behaviour to fluency does not ensure that all the components of that behaviour are firmly established in the learner’s repertoire of skills. This study emphasises the importance of analysing tasks, identifying each component and structuring the curriculum so that each component is taught to a specific level of fluency before moving on to the next. Rather than being seen as a lengthy, time costly procedure, the evidence from this study suggests that initially ensuring all components are in place actually reduces the time required to teach more complex skills as the learner moves through the curriculum.

Further research is necessary to strengthen this argument. Participants attended two, thirty minute sessions per week and only two component skills were targeted for intervention. Longer, more frequent teaching sessions and the inclusion of more components skills may have produced higher learning celerations on tasks under intervention, which may have resulted in higher celerations on tasks not under intervention. Future studies could also focus on larger groups and across different populations of learners. More important however is the fact that studies may need to design for more control over practice effects and classroom variables to more accurately assess the effect fluency in component skills plays in learning and performing new tasks.

REFERENCES


This investigation evaluated a senior citizen’s self-management of positive and negative inner behaviours, namely thoughts and feelings. Throughout the course of the study every instance of positive and negative inners per day was counted, recorded and charted on a Standard Celeration Chart. Following baseline (Condition A), the initial intervention strategy involved the introduction of timed counting procedures, varying between 30-seconds and 1-minute in duration, during which the participant was instructed to freely tally as many positive inners as possible (Condition B). Resultant data led to the implementation of response-prompt practice and assessment procedures (Condition C), which included SAFMEDS and a personalised response-prompt worksheet designed by the participant for use during daily 1-minute counting periods. Behaviour maintenance was determined by a return to baseline (Condition A) and subsequent follow-up assessment (Condition D). The main finding was that response-prompt procedures (Condition C), particularly the personalised response-prompt worksheet, proved most effective in increasing the frequency of positive inners, both during daily 1-minute counting periods and throughout the day, whilst reducing the frequency of daily recorded negative inners. The implications of these findings in relation to future research and applications are discussed.

DESCRIPTORS: Inners, inner behaviour, elderly, behavioural gerontology, SAFMEDS, counting periods

The recurrent theme of inner behaviour research, as evidenced in the growing literature, has been the overwhelming effectiveness of what is, essentially, a fairly simple exercise of self-management. By increasing our awareness of those thoughts and feelings that have the potential to both provide assurance and inner well-being alongside those that, in the long-term, are potentially harmful and may upset the equilibrium, general "mental well-being" can be achieved. Research has repeatedly demonstrated how this skill can pay substantial dividends in terms of "inner" health (Duncan, 1971; Conser, 1981; Calkin, 1981, 1992, 2001; Cooper, 1991; McCrudden, 1989; Kostewicz, Kubina & Cooper, 2000).

Nevertheless, despite the increasing popularity of inner behaviour research in recent years and the sentiment that precision teaching (PT) is ubiquitous in its application across the ages (White, 1986), it is surprising that there has been relatively little attempt to broaden its application to a population for whom the potential benefits are great - the elderly.

Statistics are often interpolated into discussions concerning elderly mental health. For example, elderly suicide rates in the United Kingdom are particularly worrying. The highest rate of suicide for any age group is amongst men aged 75 and over, research indicating that 60-90% of suicides and attempts are made following symptoms of depression, pain and feeling unwell (Social Services Inspectorate, 1997).

In highlighting the effects of a growing global elderly population, Kubina, Haertel, and Cooper (1994) first pointed out the huge potential for an amalgamation of inners research and behavioural gerontology. However, despite their findings and recommendations, no one has followed their lead. The reasons for this apparent research caution can only be speculated, but are possibly not dissimilar to those that have beleaguered the behavioural gerontological world for some time (Carstensen, 1988).

In view of the above considerations, the purpose of this study was to examine and evaluate the effectiveness of a senior citizen’s self-management of positive and negative thoughts and feelings using a variety of PT-directed behavioural strategies.

METHOD

Participant

The participant was a female aged 66 years who, for the purpose of this study shall be called “Kathy.” Kathy required assistance in daily living throughout the day because of a number of medical conditions, including hypertension, arthritis, and severe back pain, the latter of which greatly impeded mobility. Owing to reports of increasing tendencies to focus upon the negative aspects of life, often in the form of negative thoughts and feelings about herself and situations in which she found herself, Kathy willingly agreed to take part in the investigation.

*This study was supported by joint funding from the University of Ulster at Coleraine and the Northern Health and Social Services Board, Northern Ireland
Setting

Introductory instruction meetings concerning with data collection and plotting, and follow-up meetings took place in Kathy's home. The actual recording of inner behaviour was carried out wherever Kathy was throughout the day when she experienced those behaviours, be it in the home, car, and so on.

Definition of Target Behaviours

Both positive and negative thoughts and feelings were identified as the target behaviours of this investigation.

As with all inner behaviour, the exact nature of the target thoughts and feelings experienced was specific to Kathy, thus preventing the construction of a definitive list of the behaviours to be recorded. However, as a guide, positive feelings were defined as pleasant emotional states, often accompanied by a physical sensation related to the feeling. Examples might include “I feel intelligent/prett/dependent/happy/etc;” “I'm excited;” “I did a really good job,” whilst positive thoughts were positive self-observed ideas not accompanied by a physical sensation as to suggest the individual's own conviction in the thought. To illustrate, examples of positive thoughts include “I am intelligent/beautiful/happy/etc,” “That’s a pretty picture,” “It’s a nice day.”

Negative feelings were identified as unpleasant emotional states accompanied by a corresponding physical sensation. Examples of negative feelings include “I feel stupid/ugly/unhappy/etc;” “I'm fat;” “I’ve really messed things up this time;” “No one cares about me.” On the other hand, negative thoughts were defined as negative self-observed ideas not accompanied by a physical sensation as to suggest the person’s own conviction in the thought. Such negative thoughts might include “I am incompetent;” “What a wet and miserable day;” “That’s such a mess.”

Measurement

The first learning channel set used by Kathy was “free/tally,” wherein Kathy was required to freely think of positive and negative thoughts and feelings that were then “tallied” using a notebook and pen. Consequently, Kathy obtained a record of the number of times both positive and negative thoughts and feelings were experienced each day (Conditions A & B), either throughout the course of the day or during timed counting periods (i.e., 1-minute; 45-seconds; 30-seconds). With the introduction of the second intervention phase (Condition C), and the utilisation of the positive thoughts and feelings SAFMEDS cards and its derivative personalised response-prompt worksheet, the “see/say” learning channel was adopted, wherein Kathy was instead required to read aloud the positive inners printed during the counting periods. Kathy used a digital kitchen timer to accurately measure the counting periods used and all data obtained was plotted on a personalised Standard Celeration Chart (SCC).

PROCEDURE

Condition A

The purpose of this phase of the investigation was to ascertain a steady rate of responding for Kathy in terms of the number of positive and negative thoughts and feelings experienced each day. In this instance the baseline phase lasted 14 days, by which time a steady target behaviour frequency was established.

Condition B

In addition to the recording of both positive and negative thoughts and feelings throughout the day Kathy carried out a daily 1-minute timing wherein for every positive thought and/or feeling experienced during the timing period she was asked to make a tally mark (free/tally learning channel), the objective being to think freely think of positive and negative thoughts and feelings in 1-minute and thus achieve the aim set at 50-75 positive thoughts and feelings per minute. Though the 1-minute counting period was used initially, data obtained led to the counting period being reduced to 30-seconds, after which a number of variations in the counting periods were introduced to facilitate the free/tally of positive inners.

Condition C

As in Condition B, Kathy recorded both positive and negative thoughts and feelings throughout the day. However, in this instance the daily free/tally 1-minute timing of positive thoughts and feelings was initially replaced by a see/say 1 minute timing of positive thoughts and feelings using SAFMEDS (say All Fast a Minute Each Day Shuffle) cards. On each card a positive thought or feeling specific to Kathy was printed. During 1-minute timings Kathy was required to see/say as many SAFMEDS as possible until aim was consistently met. After a period of time the content of the SAFMEDS cards were condensed onto a single A4 worksheet, and the learning channel set changed to see/silent read.

No restriction was placed on the number of times this part of the intervention could be carried out each day. Thus, Kathy was free to repeat the see/say or see/silent read exercises as many times as she wished; increased practice was entirely optional. In each case the greatest number of SAFMEDS responded to in an individual 1-minute counting period was recorded on the SCC for each day. For example, in a day where the minimum
and maximum number of SAFMEDS responses per minute is 45 and 77 respectively, the data plotted for that day would be 77.

Condition A. With the withdrawal of positive inners 1-minute timings, Kathy returned to the baseline procedure wherein only the number of positive and negative inners experienced throughout the course of each day was recorded. This phase lasted 36 days.

Condition D. After an interval of 36 days, during which no data was collected, a follow-up assessment to determine behaviour maintenance/retention was carried out over a period of 27 days. The procedure outlined in Condition A above was followed.

RESULTS

Condition A. Charts 1 and 2 show the occurrence of positive and negative inners for Kathy throughout the entire study. During Condition A (Chart 1) the frequency of positive inners ranged from 39 to 76 per day (mean = 47.8) with a celeration value of +1.15 whilst the frequency of negative inners ranged from 68 to 83 per day (mean = 75.4), decelerating at -1.1. Aside from one day when the number of positive inners exceeded negative inners experienced (positive = 76; negative = 68), negative inners were consistently higher than positive inners.

Condition B. Under this condition timed counting periods were introduced. Though positive inners accelerated at x6.25 (from 8 to 50) during this 11-week intervention phase, this was the product of a number of counting period changes. For instance, initially, the 1-minute counting period was used, however, given the celeration value of x1.0 after 14 days, the counting period was reduced to 30-seconds. This, followed by a number of variations in the counting periods used, ultimately resulted in the overall x6.25 celeration value.

In terms of the effect of the counting periods upon positive and negative inners recorded daily, after the first day, between Conditions A and B, positive inners had accelerated by x1.25, from 39 to 49 per day, whilst negative inners decelerated by -1.4, from 75 to 55 per day. However, by the end of Condition B positive inners had accelerated by x2, with a frequency spread of 49 to 96 per day, whilst negative inners had accelerated by x1.2, from 55 to 67 per day.

Condition C. With the introduction of SAFMEDS, one day into Condition C the frequency of positive inners recorded during the 1-minute counting period had accelerated by x1.3, from 50 to 64 per minute. A steady acceleration of responding during the daily counting periods was further reflected in the x1.9 celeration value obtained by the end of Condition C.

Initially, both daily recorded positive and negative inners accelerated by x1.3 (positive - from 96 to 129; negative - from 67 to 87). However, Charts 1 and 2 clearly illustrate that by the end of Condition C negative inners had decelerated by -3.0, from 87 to 30 (range = 27-87), whilst the acceleration in positive inners made prior to the introduction of the response-prompt procedures continued throughout Condition C, accelerating at x1.8, from 129 to 227 (range = 123-229).

Condition A. Chart 2 shows the occurrence of positive and negative inners during the remainder of the study (Condition C continued, Condition A, and Condition D). Though little significant change in the frequency of positive and negative inners recorded throughout the day was experienced initially following the return to baseline (x1.0 and +1.1 respectively), by the end of the condition positive inners had accelerated by x1.3, from 236 to 305 per day whilst negative inners decelerated by -4.5, from 27 to 6 per day (Chart 2).

Condition D. After a 36-day interval during which no data was collected the follow-up assessment was carried out. As illustrated in Chart 2, during this 27-day period positive inners accelerated at x1.1 (range = 295-319) with a mean of 305 positive inners per day, whilst negative inners had a static celeration value of 1.0 (range = 17-23) and a mean of 21 negative inners per day.

DISCUSSION

During the course of this self-management of positive and negative thoughts and feelings, positive inners recorded during the daily 1-minute counting periods accelerated by x15.0 (range = 8-119). The effect upon inners recorded throughout the course of the day was that positive inners accelerated by x7.0 (range = 45-319 per day) whilst negative inners decelerated by -5.0 (range = 17-83 per day). These results clearly show that of the two interventions used by Kathy to increase the frequency of positive inners whilst decreasing the frequency of negative inners the personalised SAFMEDS-based response-prompt worksheet proved most effective.

Though the free/tally positive inners intervention (Condition B) did produce a significant acceleration of positive inners during the various counting periods, its effect upon positive and negative inners recorded throughout the day was much less impressive. During this condition, and particularly during the longer counting periods (>30 secs.) Kathy, experienced great difficulty trying to think of as many positive
Chart 1

A      B      C

Count Per Minute

0.001  0.01   0.1    1    10    100

Successive Calendar Days (by weeks)

Behavior: Kathy

Target: Positive and negative reinforcers
thoughts and feelings as possible, hence the various changes in the duration of the counting periods used. However, though attempts were made to gradually increase the duration of the counting periods to the maximum of 1-minute, the frequency of positive thoughts tallied during these times tended to decrease. Other, more general explanations for the ineffectiveness of Condition B might include deterioration of recall due to increasing age and fewer social opportunities due to immobility.

The SAFMEDS-based response-prompt procedures (Condition C) produced not only an increase in the frequency of positive inners either spoken or silently read during the daily 1-minute counting periods but also much less erratic responding, the acceleration being steadily dramatic. This effectiveness was clear one day into Condition C when the frequency of positive inners recorded during the 1-minute counting period accelerated by x1.2, from 50 to 64 per minute. And, as time progressed it became quickly apparent that the SAFMEDS cards were having the desired effect. This effect was later exemplified with the introduction of the SAFMEDS-based personalised response-prompt worksheet, which further accelerated the frequency of both daily and timed positive inners whilst dramatically reducing negative inner frequencies per day.

During the subsequent return to baseline (Condition A) it was evident that even with the withdrawal of Condition C, the effects of the SAFMEDS-based response-prompt worksheet on Kathy’s positive and negative inners were maintained. In fact, negative inners decelerated quite dramatically whilst positive inners continued to steadily accelerate. It is clear that by this stage Kathy had become fluent in focusing upon more positive thoughts and feelings, aided by the prompts and practice provided in Condition C, to the point where negative inners seldom occurred.

Some 36 days after the return to baseline phase had ceased, the follow-up analysis (Condition D) indicated that though negative inners recorded throughout the day had increased slightly, perhaps due to the break in experimentation, positive inners continued to accelerate steadily. This illustrates how, even after such a long period where no data was collected and behaviour was not monitored closely, the behaviour learned had maintained. This supports the findings of Kubina, Haertel, and Cooper (1994) alongside the behavioural gerontological literature that has repeatedly highlighted the ability of older people to learn and benefit from behaviour management strategies.

In contrast to Calkin (1981), whose study measured seven different behaviours and treated thoughts and feelings separately, this investigation had only two measures, namely positive thoughts and feelings and negative thoughts and feelings. Though there are advantages of such an analysis, time restraints ruled this out in this instance. However, as Calkin (1981) stated "To count that many inners at one time requires practice" (p. 10).

A further disparity between this examination of inners and that by Calkin (1981) is that in this instance no specific daily aims for the positive inners recorded throughout the day were set, though Kathy was aware of some of the general aims for positive inners during counting periods (i.e., free/write positive thoughts and feelings = 30-50 per minute; free/say positive thoughts and feelings = 50-75 per minute). Calkin believed that this procedural inclusion might have played a pivotal role in increasing positive inners. However, the findings of this study suggest that whilst such a procedural inclusion may be useful, it is not necessary. Rather, Kathy found that the return of information about her progress, both from the daily-recorded data and verbally from the experimenter, was intrinsically reinforcing, encouraging Kathy to strive to improve the frequency of positive inners each day.

In conclusion, though research findings suggest that "the behavioural community will benefit greatly from improving inner behaviour research methods, such as the one-minute counting period" (Kubina, Haertel & Cooper, 1994), inner behaviour research is continually shunned. However, in further demonstrating the applicability of inners research to the elderly population, whilst highlighting the potential of PT-directed SAFMEDS-based behavioural strategies in combination with counting periods, the findings reported here will contribute to this debate.

REFERENCES


Comparing levels of dysfluency among students with mild learning difficulties and typical students

Claire McDowell, Michael Keenan and Ken P. Kerr
University of Ulster at Coleraine

This study compared the extent to which two groups of learners, one mildly learning disabled and the other typically developing, were dysfluent in a compound task they had difficulty learning and performing and two component skills of that compound. The results showed that all fifteen learners were dysfluent in both the component skills identified and the compound task itself. Further more there were only slight differences in the extent to which either group were dysfluent.

DESCRIPTORS: Dysfluency, compound behaviour, component behaviour

Fluency orientated educators have stressed the important role fluent component skills play in facilitating student’s progress through the curriculum. They state that students who are dysfluent in basic components and prerequisites find learning and performing more complex skills that depend on these components difficult. They highlight that dysfluent behaviour components, despite being accurate, accumulate to form an unstable foundation of core skills. Through classroom-based research they have found that dysfluent skills mount and make the acquisition of higher composite skills more difficult. Learning each new skill becomes more strenuous because learners will always experience difficulty with certain elements of the task (Johnson & Layng, 1992). Proponents of fluency call this accumulation of dysfluent skills “cumulative dysfluency,” and believe that it may be the most important factor in long-term student failure (Binder, 1996).

Given the findings of PT research into component fluency, conducted with both learning disabled (LD) and typical students, it may be hypothesised that children experiencing difficulties learning new skills may be dysfluent to some degree in one or more components of the target composite behaviour, irrespective of educational labels. This study was conducted in order to assess the extent to which a group of students experiencing difficulties learning new skills may be dysfluent to some degree in one or more components of the target composite behaviour, irrespective of educational labels. This study was conducted in order to assess the extent to which a group of students experiencing difficulties learning new skills may be dysfluent to some degree in one or more components of the target composite behaviour, irrespective of educational labels.

Participants

Group 1 comprised seven learners, (five males and two females), who had been diagnosed by educational psychologists as having mild learning difficulties (MLD). Six of the participants (four males and two females) attended a school for children with learning difficulties and one (male) attended a regular primary school where he attended remedial classes for help with reading and mathematics. Three of these children had been identified by their teacher as having difficulties reading key words from their reading series, three had been identified as having difficulty learning x4 multiplication tables, and one had been identified as having difficulty learning addition with the number “2.” The participant’s ages ranged between 8 and 11 years at the time of the experiment. Group 2 comprised eight typical students (2 females and six males) none of whom had been diagnosed as having learning difficulties and who attended regular primary school. These participants were identified by teachers as having difficulties learning x3 and x4 multiplication tables. These participants’ ages ranged from 8-9 years at the time of the experiment.

Tasks

Target compound tasks were selected based on teachers’ and parents’ recommendations of curriculum areas in which learners were experiencing difficulty. Fluency aims were set based on Precision Teaching (PT) recommendations or by having competent performers (university undergraduates) perform the skill for several, 1 minute timings and taking an average of their highest scores. Compound tasks and learning channel sets were as follows;

Group 1 (MLD):
• Learner M - see/write answers to x4 multiplication problems
• Learners L & P - see/write answers to x2 multiplication problems
• Learner C - see/write answers to +2 addition problems, and Learners D, E & J - hear/see point to isolated key words.

METHOD
Group 2 (Typical):
- Learners Mi, N, Da, R & Ch - see/write answers to x4 multiplication problems
- Learners S, F & W see/write answers to x3 multiplication problems

Task Analysis
Each composite skill was analysed for key component skills. Two key component skills of each compound task were selected for testing. Again, aims were based on PT recommendations and on competent performer's average scores. Component skills and learning channel sets were as follows:

Group 1 (MLD):
- Learner M - Component Skill 1 - see/dot multiples of 4 on number grid (60-80 dots per min.), Component Skill 2 - see/write answers to add 4 problems (70-90 digits per min.).
- Learners L & P
  Component Skill 1 - see/dot multiples of 2 on number grid (80-100 dots per min.)
  Component Skill 2 - see/write answers to add 2 problems (70-90 digits per min.)
- Learner C
  Component Skill 1 - see/say numbers 1-50 (60-80 numbers per min.)
  Component Skill 2 - see/write answers to add 1 problems (70-90 digits per min.)
- Learners D, J & E
  Component Skill 1 - see/say letter sounds from flashcards (60-80 sounds per min.)
  Component Skill 2 - see/say 2 letter syllable sounds from flashcards (60-80 sounds per min.)

Group 2 (Typical):
- Learners Mi, N, Da, R & Ch
  Component Skill 1 - see/dot multiples of 4 on number grid (60-80 dots per min.)
  Component Skill 2 - see/write answers to adding 4 problems (70-90 digits per min.)
- Learners S, F & W
  Component Skill 1 - see/dot multiples of 3 on number grid (60-80 dots per min.)
  Component Skill 2 - see/write answers to adding 3 problems (70-90 digits per min.)

PROCEDURE
Figure 1 shows the procedure used in this study. All participants in Group 1 were assessed separately and participants in Group 2 were assessed in groups of four. All were assessed for fluency levels on the compound task by asking them to perform that task for 1 min on 2 successive days. No instruction or teaching occurred during these sessions. Scores were charted as rate of correct and incorrect responses per minute. All participants' performances on each of the component skills were tested by asking them to perform each of the tasks for 1 minute on 2 successive days. Again, no teaching or instruction took place during these sessions and the order in which tasks were presented was randomised to control for practice effects. Scores were recorded as rate of correct and incorrect responses per minute.

RESULTS
Compound Tasks. Figure 2 presents Group 1 participants' rates of correct and incorrect responding on the compound tasks tested over 2 days. All participants showed varying but significant levels of dysfluency in these tasks. The range of correct scores on the see/write maths tasks (aim 70-90 digits per min.) was 3-25. Incorrect scores on these tasks ranged from 0-4. The mean rate of correct responding on this task was 13 digits per min., an average of 57 responses less than the minimum fluency aim range. The mean rate of incorrect responding was 1 digit per min. Correct scores on the see/hear/point reading task (aim 40-60 words per min.) ranged from 5-8. Incorrect scores on this task ranged from 3-5. The mean rate of correct responding on this task was 7 words per min., an average of 33 responses below the minimum fluency aim. The mean rate of incorrect responding was 4 words per min.

Figure 3 presents Group 2 participants' correct and incorrect scores on the compound tasks tested over 2 days. Again the results indicate varying, yet significant, levels of dysfluency across tasks and participants. The rate of correct responding on the x3 and x4 see/write math tasks (aim range- 70-90 digits per min.) ranged from 8-34. The rate of incorrect responding on this task ranged from 0-8. The mean rate of correct responding for these participants was 24 digits per min., an average of 46 responses below the minimum fluency aim. The mean rate of incorrect responding was 1 digit per min.

Component Skill 1 Group 1 participants' correct and incorrect responses during baseline testing of Component Skill 1 are presented on Figure 4. Correct rate of responding on math components ranged from 13-31. Rate of incorrect responding on these tasks ranged from 0-12. Mean rate of correct responding was 21, some 59 responses less than the minimum fluency aim for 3 participants and 39 responses less than the minimum fluency aim for 1 participant. Mean rate of incorrect responding was 3. Correct responding on the reading Component Skill 1 ranged from 22-
Group 1 participants (MLD) selected based on teacher concerns

Baseline measures of fluency level on compound task

Task analysis of compound task for component skills

Baseline measures of fluency level on component skill 1 (2 sessions)

Baseline measure of fluency level on component skill 2 (2 sessions)

Group 2 participants (typical) selected based on teacher concerns

Baseline measures of fluency level on compound task

Task analysis of compound task for component skills

Baseline measures of fluency level on component skill 1 (2 sessions)

Baseline measure of fluency level on component skill 2 (2 sessions)
Rates of correct responding ranged from 17-30. Baseline rates of responding on Component Skill were below the record floor. 34 responses less than the minimum fluency aim. The mean rate of correct responding was 26 letters per min., some 37 responses below the minimum fluency aim. The mean rate of incorrect responding was 0, below the record floor.

Figure 5 shows Group 2 participants' baseline rates of responding on Component Skill 1. Rates of correct responding ranged from 17-30. Rates of incorrect responding ranged from 0-7. The mean rate of correct responding on this task was 23, some 37 responses below the minimum fluency aim. The mean rate of incorrect responding was 0, below the record floor.

**Component Skill 2.** Figure 6 shows Group 1 learners' rates of correct and incorrect responding on math Component Skill 2. Rate of correct responding ranged from 8-24 and incorrect responding ranged from 0-2 on this component. The mean rate of correct responding was 15 digits per min., 55 responses less than the minimum fluency aim. The mean rate of incorrect responses was 0.5. Rate of correct responding on the reading component skill ranged from 3-24, and rate of incorrect responding ranged from 1-5. The mean rate of correct responding was 12 sounds per min., some 48 responses less than the minimum fluency aim. The mean rate of incorrect responding was 3 per min. Figure 7 shows Group 2 participants' correct and incorrect scores on Component Skill 2. Rate of correct responding ranged from 6-30 and rate of incorrect responding ranged from 0-8. The mean rate of correct responding was 20 digits per min., some 50 responses less than the minimum fluency aim. The mean rate of incorrect responding was 0, below the record floor.

**Group Comparisons.** Baseline measures of rates of responding allowed a between-group comparison of levels of dysfluency in compound math tasks and math components. Figure 8 shows Group 1 and Group 2 participants' mean rates of responding on all math tasks. On the math Compound Task Group 1 participants' rate of responding was on average 57 responses less than the minimum fluency aim. Group 2 participants' rate of responding was on average 46 responses less than the minimum aim, a difference of 11 responses per min. On Component Skill 1, Group 1 participants responded on average 59 responses less than the minimum aim. Group 2 participants responded at a rate of 37 responses less than the minimum aim, a difference of 22 responses. On Component Skill 2, Group 1 participants responded an average of 55 responses less than the minimum fluency aim. Group 2 participants made an average of 50 responses less than the minimum aim, a difference of 5 correct responses.

**DISCUSSION**

These results show that all seven pupils in Group 1 and all eight pupils in Group 2 were dysfluent in the compound task being taught in the classroom and dysfluent in 2 important components of those tasks. The levels of dysfluency in the compound task are expected, given that these skills had been identified as ones in which the participants were experiencing difficulty learning and performing. The levels of dysfluency in the performance of the component skills by all participants are particularly significant however, given that these tasks form the foundations of all Math and English tasks they will encounter in early education. These tasks were no longer under instruction in either classroom which indicates that the teachers may have been unaware of the extent to which the participants were still experiencing difficulty performing these basic skills. More worrying still is that even if they were aware of these difficulties, teachers may have felt unable to do anything to remediate these problems.

Group comparisons on the math tasks show that learners with MLD in Group 1 showed slightly higher levels of dysfluency on all skills than typical learners in Group 2. They were, on average, 11 responses more below the minimum fluency aim on the Compound Task than group 2 participants; 22 responses more below the minimum fluency aim on Component Skill 1 than Group 2 participants; and 5 responses more below the minimum fluency aim than Group 2 participants on Component Skill 2.

As indicated earlier, the differences in the levels of dysfluency between groups are perhaps not surprising given that Group 1 participants have been recognised as having learning difficulties. However, these results may be indicative as to why observed learning difficulties arise and persist in some children. Failure to learn and perform basic prerequisite skills in early education may permanently influence learning and performance on all related skills. The higher the level of dysfluency in component skills, the more difficult it is to learn related skills, which leads to a general label of learning failure.

Given that all fifteen pupils had been selected by teachers as showing difficulty progressing in a particular area, these results support claims made by PT literature, suggesting that cumulative dysfluency is, and continues to be, an important factor in long-term academic failure (Binder, 1996). Despite evidence such as this showing the importance of fluent component skills before compound skills are taught, regular classrooms appear to concentrate on teaching skills.
to accuracy, in the order the curriculum denotes. They do not test students' behavioural repertoires for fluency upon entry to the education system and so are unaware of, or continue to ignore, the accumulation of dysfluent components. Barrett (1979) wrote that equating accuracy with mastery makes it difficult to detect dysfluency in skills prior to its ultimate cumulative effect. Although based on a very small sample, these results suggest that cumulative dysfluency may very well be a contributing factor in educational failure for both LD children and their typical peers. An important starting point in establishing PT in schools will be in the teaching of component skills to fluent levels to redress the problem of cumulative dysfluency in our classrooms.

REFERENCES


The Saplings Model of Education: Case Studies in Autism

Ken P. Kerr, Audrey Campbell, and Shauna McGrory

The Saplings Model of Education

The Saplings Model of Education is a school in Ireland which offers children with autism access to individualized teaching using the framework of Applied Behavior Analysis (ABA), Precision Teaching, and Direction Instruction. This paper presents an outline of the Model, which incorporates teaching, training, and research, and delineates key operating principles. Learning pictures for three children with autism are also presented for a selection of tasks.

DESCRIPTORS: Autism, Saplings, Precision Teaching, Education

A major goal in the education of children with autism is the acquisition of behavior which will help them learn from their natural environment. Autism itself is characterized by impairments in social relationships and communication together with restricted, repetitive, and stereotyped patterns of behavior, activities, and interests. Whilst the efficacy of behavioral approaches to educating children with autism has been clearly shown over the last 20 years (see Matson, Benadivez, Compton, Paclawskyj, & Baglio, 1996; Kerr, 2000) little has been published on Precision Teaching (PT) with children with autism (for exceptions see Malabello, 1998; Kubina, Morrison, & Lee, 2002). Green (1996) stated that: The vast majority of the child’s time and other resources ought to be invested in treatments that have been shown, through scientific research, to produce the most lasting beneficial effects on the broadest range of behavioral deficits and excesses that constitute autism. (p. 17)

Kubina et al., highlight Precision Teaching (PT) as a method for providing daily assessment of progress which can also assist planning of curricular decisions. Adopting such an adjunct compliments existing curricula and allows for measuring behavior and facilitating decision-making. In a similar vein, West, Young, and Spooner (1990) reminds us of the importance of being aware of the relationship between teaching and learning: Teachers who are truly interested in ensuring that teaching has had the intended effect will certainly be interested in precise measurements of learning. More important, however, they will want to adjust their teaching practices when the measurements indicate that prior instruction has failed to accomplish its objective. Therefore, measuring learning is one of the most important of all instructional acts. (p.5) This is of central importance to practitioners working with children with autism. Understanding the nature of the teacher-learner dyad results in positing questions in regard to whether the pupil is learning and the speed of acquisition. Also, remedial questions concerning what should be done if the pupil is not learning and what level of performance should be expected arise from the introduction of precision measurement to the teaching process (cf. Raybould, 1981). Saplings attempts to address these issues for each of the children enrolled through the use of PT as an assessment through teaching model, thereby providing all children with a high level of individualized and appropriate education. This paper describes our approach to teaching and learning and introduces three children from Saplings, namely, Rob, Mary, and Mike in order to illustrate the type of tasks taught and the effectiveness of the teaching. The paper is a celebration of all that has been achieved in Ireland over the last few years. We recognize the work of all tutors and parents in creating the model and look forward to developing our skills in the related areas of PT and ABA.

The Saplings Model

The School and Students. Saplings is a purpose built centre consisting of three large classrooms, which accommodate 4 children in each. These classrooms can be observed from two observation rooms. In addition there are two individual tuition rooms and a large playroom with a variety of play equipment. Cameras have been installed in all rooms to record teaching sessions. Outside there is a large play area with a trampoline, swings, slides etc. The school is situated in a rural area about 30 miles from Dublin. Saplings currently have 12 children enrolled on the programme (11 boys and 1 girl) with age ranging from 3 years to 8 years. All children were diagnosed with autism by an independent educational psychologist prior to enrollment at Saplings. The school has 14 tutors, one Supervisor and a Director of Education (behavior analyst) and
operates a 48 week academic year with standard school holidays for all staff and children. The school day starts at 9:15 for tutors and at 9:30 for children and ends between 2pm and 3pm for children with tutors staying until 4pm to review programs and plan for the following day’s lessons. Each child has a tailor made individualized programme, which covers a wide range of educational domains (e.g., language, motor skills, social skills, play skills, self-help). The majority of children are taught individually in classrooms with other children. Direct Instruction programs, varying from Reading Mastery, math, and language are in place for 7 of the children. All children also take part in daily group work tasks. The ethos of the school is to provide children with autism access to an educational framework which allows children to master pre-requisite skills to a fluency level.

The teaching methodology of Saplings is based upon the principles of Applied Behavior Analysis (ABA) incorporating Precision Teaching which allows flexibility in the teaching and learning process. All tutors have attended introductory courses in ABA and PT. They have also been trained in Direct Instruction which provides a structured systematic approach to academic learning in our school. Tutor training on a monthly basis provides ongoing professional development for staff which means the children receive a high quality of teaching.

The general model within Saplings is made up of essential elements of PT including:

- Pinpoint. Tutors pinpoint or specify the correct response to accelerate and the incorrect response to decelerate. This allows Individualized Program Plans (IPP) to be written for each child which highlights a general educational path for each child.
- Count. Once pinpointed tutors collect information on the behavior. This is counted in the form of the correct responses and incorrect responses for each skill area.
- Chart. By creating learning pictures we can see immediately whether or not progress is being made. The use of the Standard Celeration Chart allows tutors to make minute to minute changes in the teaching process. Scrutiny of progress toward learning goals embraces the spirit of early intervention.
- Pre-Teaching Assessment - Children are presented with each task prior to teaching to ascertain current competency for each individual. In this way the pitch and pace of the instruction can also be considered prior to intervention.
- Intervention. Based upon pre-teaching scores interventions are designed. The fundamental axiom of the “learner knows best” is adhered to at all points of the education planning process.

- Fluency and Cumulative Curriculum Planning. Effective planning of a comprehensive curriculum to establish key component skills and their underlying tool elements to fluency is central to the work at Saplings (cf. Johnson & Layng, 1994). Mastery of each task is determined by showing retention, endurance, and application in relation to performance standards whilst showing stability of responding.
- Self-Management. Placing the child at the centre of the learning process within Saplings is possible by allowing all children to choose their rewards/playtime activities. Some of the children use visual icons to denote their choice whilst others vocally request items.

Informed Decision-Making: Using Learning Pictures

Through application of the above mentioned elements at Saplings since October 2001, we have been able to collect several hundred charts showing the progress of the children and tutors in implementing PT. The following cases are provided to give a flavor of the work and progress we have committed to at Saplings.

Rob. Rob is 4 years 9 months old and was diagnosed as having mild to moderate autism at 2 years 6 months old. He has been attending Saplings since 30.10.01 and was engaged in a one-to-one home-based ABA program for the year preceding his enrollment. His active task list includes tasks such as see/say words, see/write letters and numbers, and hear/answer questions on function while tasks in maintenance range from see/say body parts to hear/do prepositions. Charts 1 – 3 show the learning pictures before, during, and after teaching for the tasks hear-give objects by function, see-say clothes, and see-say body part cards.

Mary. Mary is 4 yrs 6 months old and was diagnosed as having autistic spectrum disorder just after her 2nd birthday. She has been attending Saplings since 30.10.01 and was engaged in a one-to-one home based ABA program for one year prior to enrollment. Mary’s current tasks include see/say phonics, see/match non-identical actions, hear-give pictures, see/match word to picture and see/write numbers. Charts 4 – 5 show the learning pictures before, during, and after teaching for see-match non-identical pictures and see-match emotion cards.

Mike. Mike is 3 years 8 months old and was diagnosed as having mild autism at the age of 3 years 1 month. He has been attending Saplings since September 2001 and had been receiving one-to-one tuition at home, based on the principles of...
Chart 1

Target: Hear-Give Objects by Function

Owned by: Rob (4 years old)

Retention

30 seconds 5 objects

Successive Calendar Days (by weeks)

Count Per Minute

Initial Assessment

Added two, randomized

Added two more

Added two, randomized all

13 objects

0.001 0.01 0.1 1 10 100 1000

0 7 14 21 28 35 42 49 56 63 70 77 84 91 98 105 112 119 126 133 140

01/25/02

02/22/02

03/22/02

11/02/01

11/30/01

12/28/01
Count Per Minute

Successive Calendar Days (by weeks)

Chart 2:
Owned by: Rob (4 years old)
Target: See/Say Clothes

Teaching began: 10 cards, 10s
Changed timing, randomized all
Randomized all
Retained
Added 3 more
Added 4 more
Added 3 more

11/02/01
11/30/01
12/28/01
01/25/02
02/22/02
03/22/02
Chart 3:

Owned by: Rob (4 years old)

Target: See/Say Body Part Cards
Figure 5

Chart 5: See/Match Emotion Cards
Task: Owned by Mary

- Initial Assessment
- Teach 4 emotions
- Add 4 more
- Add 3 more
- Increase timing to 30 seconds
- Increase timing to 1 minute
- Retention
- Hols Xmas

Successive Calendar Days (by weeks)

Count Per Minute

0.001 0.01 0.1 1 10 100 1000

01/13/02 02/10/02 03/10/02 04/07/02

09-6t S33Vd 'ZOOZ 'Z XXiVWN '81 XJWl10A 'NOILVXXIX3 aNV 3NIH3VXL NOISI33Xd $0 ~VNWOI
Count Per Minute

0.001  0.01  0.1  1  10  100  1000

0  02/17/02 01/13/02 02/10/02 03/10/02 04/07/02

Successive Calendar Days (by weeks)

Teaching 8 functions
Tutor change
Add 2 more functions
Added 1 more bicycle
Endurance Check

Task: Hear/Answer Questions on Function
Chart 7: Owned by: Mike (5 years old)
Added 2 more cards

Endurance Check - 13 cards

Teach new group (10 cards)

Endurance Check

New group (7 cards)

Teach new group (7 cards)

Retention across 2 weeks

Endurance

Chart 8:
Task:
See-Say What's Wrong/Silly?

Owned by: Mike (5 years old)

Successive Calendar Days (by weeks)

Count Per Minute

Added 2 more cards

7 cards

01/27/02

02/24/02

03/24/02

04/21/02

05/19/02

06/16/02

0.001

0.01

0.1

1

10

100

1000

7

14

21

28

35

42

49

56

63

70

77

84

91

98

105

112

119

126

133

140

Figure 8
ABA, since June 2000. Mike’s active tasks include see/count/say sums, see/say sequencing, see/say why–because, and hear/put prepositions. Mike’s tasks in maintenance range from see/say phonics to see/match letters to keyboard. Charts 6 – 8 show the learning pictures before, during, and after teaching for the tasks see/say description based on feature, function, and class, hear/answer questions on function, and see/say what’s wrong or silly.

Training Courses & Research

To address the uneven pattern of development typical of children with autism, the Saplings Model of Education was created to act as a school, research centre, and training centre. This multifaceted approach is designed to tap into the evolving skill sets within education for children with autism. Placing our finger on the pulse of learning and measuring the outcomes allows Saplings to evolve. 12-week training courses which provide a basic introduction to ABA have been successfully run by Saplings throughout Ireland. The essential elements of PT outlined above are of central importance in these training courses.

Currently 3 courses are running across Ireland. Saplings aim is to provide ongoing basic training to new groups of interested parties as well as more advanced courses for those who have completed introductory level training. These courses are open to all parents and professionals with an interest in teaching children with autism and related disabilities. The courses cover aspects of ABA, verbal behavior, curriculum design, and the use of visual aides for children with Autism. Courses have been well received and through them we aim to promote the interest in, and application of, PT in Ireland whilst also empowering parents with skills in designing and monitoring effective educational programs.

With regard to research interests, Saplings are forging links with universities in order to enhance our research potential. Currently at Saplings we are investigating the effectiveness of video modeling in promoting social interaction and social commenting. The implementation of self-management packages (e.g., Koegel, Koegel, Hurley, & Frea, 1992) are also being explored. As Saplings becomes more established, it will be possible to investigate further avenues of research in a variety of important areas.

DISCUSSION

The increasing popularity of behavioral interventions for children with autism has been well documented (e.g., Matson et al., 1996). Central to the arguments for behavioral programs are calls for data-based decision making. However, scrutiny of many programs under the general name of “ABA” often reveals a lack of data used to drive the program. This is incompatible with the characteristics of ABA utilizing the methods of science including description, quantification, and analysis (cf. Cooper, Heron, Heward, Eshleman, & Grossi, 1994).

The Saplings Model of Education aims to ensure that it does not fall into this trap by keeping data based decision making at its core. By providing continuing professional training for staff and highlighting the importance of evidence based practice all of those involved with Saplings are keenly aware of this issue. Saplings recognizes the importance of “having our finger on the pulse of learning” which ties in with Lindsley’s (1972) argument that by “putting science in the hands of teachers and their students” that discoveries on an individual level would be possible. All children within Saplings have made progress with the caveat that progress has been relative to each child’s starting point. Our collection of learning pictures gives us the opportunity to learn from our learners and allows us to analyze variables which affect learning-teaching. The future for Saplings is bright.

REFERENCES


Teaching component skills to improve golf swing

Claire McDowell, Chris McIntyre, Robert Bones and Michael Keenan
University of Ulster at Coleraine

The golf swing is a complex movement that requires many body parts to operate in a sequential manner. This article presents correct and incorrect celeration courses of two component skills of the golf swing, namely grip and posture. Using stills from an instructional video, both these skills were analyzed for components. The two skills were taught to fluency aims over 3 weeks. Scores from the learner’s golf games also improved during this study.

DESCRIPTORS: Golf, component skills, fluency

The old adage that golf “is a good walk spoiled” may be much closer to the truth than many people imagine. While golf is one of the worlds most popular games it appears to be one of the most frustrating in that few people ever attain the level of skill or the consistency they desire. A direct consequence of this has been a deluge of instructional aids such as personal lessons with golf professionals, books, and videos, all with the purpose to teach the correct way to play golf.

It would seem that one of the problems in mastering the game of golf is in the golf swing itself. The golf swing is a complex movement that requires many body parts to operate in a sequential manner. If this sequence is disrupted then the desired swing may not be obtained and the golf ball may be sent in an undesired direction. Another factor, which may be linked to the frustration felt by many golfers, is inconsistency. The golfer who makes one correct swing may find it difficult to repeat it on other occasions.

In an effort to teach a sequential and consistent golf swing several methods have been tried. One attempt to teach golf skills came from Simek and O’Brien (1981). They task-analyzed the golf game into 22 behavioral components. For instructional purposes they arranged these components into progression from the least difficult too the most difficult. That is, a short putt being the least difficult, and a 200-yard drive being the most difficult. Each component was assigned a mastery criterion. For example, the easiest component was a 10-inch putt and the mastery criterion was 4, 10-inch putts consecutively holed. When the participant attained this mastery criterion a 16-inch putt was introduced. The participant progressed to each new component only if the mastery criterion was attained in the previous component.

Simek and O’Brien compared six novice golfers who had completed the “behavioral progression and mastery” criteria in eight lessons against six other novice golfers who undertook eight lessons of traditional instruction from a golfer who had taught golf for several years. The results show that when the twelve golfers played eighteen holes the behavioral progression and mastery group beat the traditional group by an average of seventeen strokes (Martin & Pear, 1996).

While the “behavioral progression and mastery” approach have proved useful in the development of complex skills such as golf, more recent developments in the study of learning may be even more potent. Precision teaching emphasizes two areas of learning that the behavioral progression and mastery method does not. Namely, the development of tool skills and the measurement of fluency (accuracy + speed). Many fluency-based programs are designed to increase the frequency of component skills rather than composite performances. Composite performances are analyzed for their key component elements and the frequencies of these elements are then increased to pre-determined frequency aims. Increased frequency of the composite performance happens as a result of increasing frequency of each component skill. This focus on building tool skills to fluency is what is known as a generative model of instruction (Johnson & Layng, 1992). When presented with new environmental requirements fluent component skills can recombine in new ways that meet the more complex requirements of a novel task.

The purpose of this study was to examine how teaching component skills to fluency would affect a compound skill. Using stills from an instructional video, two components of the golf swing, grip and posture were further analyzed for components. The correct grip of a golf club comprises of four components, including position of the fingers and thumbs on the club shaft. Correct posture comprises of five components including position of feet and legs, position of club in front of legs and angles of arms and shoulders.

METHOD

Participant and Setting

The third author of this paper, a doctoral
candidate and right-handed amateur golfer was the participant in this study. Analysis, assessment and teaching were carried out in a teaching lab at the University of Ulster, Coleraine.

Materials
Sections on grip and posture from the instructional video "Ernie Els – How to Build a Classic Swing" were analyzed using a Panasonic videocassette recorder, NV-FS88 with jog-shuttle facility to freeze frame on specific stills. Stills of correct posture were traced from the screen on to transparent film. We used a two iron clamped at an angle into a retort stand to measure grip and posture.

Pinpoints
We counted the number of times the golf club was gripped correctly in a minute and also the number of times the learner could assume the correct posture from standing in a minute. For the grip to be counted as correct, four criteria had to be met. These were: 1) that when gripping the shaft of the club the forefinger and thumb of the left-hand form an inverted V, which points towards the right shoulder. 2) That only the first and second knuckles of the left hand are visible once the right hand is placed on the shaft of the club. 3) That the inverted V formed by the right forefinger and thumb points toward the right shoulder. 4) That the shaft of the club rests on the second joint of the right forefinger (see diagram 1 and 2). If one of the criteria were not met that grip was scored as incorrect.

For posture to be counted as correct, five criteria had to be in the correct position when viewed through the traced outline on the transparency (see Figure1). These were: 1) that the feet and legs were the correct width apart. 2) That the club was in the correct position close to the right leg. 3) That the right arm was straight and the left bent at the elbow. 4) The angle of the right shoulder. 5) The position of the head. If any of the criteria were not met, the posture was counted as incorrect. Throughout this study the learner continued to play his daily game of golf and recorded scores achieved during games.

Aims
Aims for both skills were set by timing the length of time the expert from the video took to grip the club correctly (3 sec) and the length of time it took him to assume the correct posture from standing (3.5 sec). We divided sixty seconds by each total number of seconds to give an aim and set an aim range for each skill with the first aim as the mid point. The aim range for grip was 15-30 corrects per min. The aim range for posture was 15-30 per min.

PROCEDURE

Analysis
We began by analyzing the sections of the instructional video on grip and posture for components of these two skills. Through listening to the narrative and watching slowed segments and stills of film the first and second authors devised four criteria that determined the correct grip, and five criteria that determined correct posture. The participant was not informed of the criteria of the two component skills until the intervention. A still frame showing correct posture was traced from the screen onto transparent film.

Baseline
A two iron was clamped into position using a retort stand. The learner was asked to assume correct grip on the handle of the club from a standing position (with hands by his sides) marked on the floor with tape. Timing began once the learner stepped from the mark, the timer was paused when the learner said, "OK", indicating he had assumed the correct grip. The grip was then examined by the first and second authors and marked as either correct or incorrect if the three criteria were present. The learner stepped back onto the mark and timing resumed again when he stepped off it. This procedure continued until 1 minute elapsed. Baseline measures for posture followed a similar procedure. Again timing began once the learner stepped off the mark up to the club. He indicated that the correct posture had been assumed by saying "OK" and the timer was paused. This time the authors viewed the learner through the traced outline of the correct posture on transparent film. The posture was scored as correct or incorrect dependant on whether all five criteria were present. The learner stepped back onto the mark and timing resumed again when he stepped off it. This procedure continued until 1 minute elapsed. No instruction, prompts or feedback were given at any time during baseline.

Repeated Practice, Instruction, and Feedback
After one baseline measure for each skill, intervention consisted of teaching sessions where, under instruction from the first and second authors, the learner would repeatedly practice gripping the club. He was given feedback as to what criteria were correct or incorrect. The same technique was used to teach posture with the addition of a floor mat placed in front of the club, showing the correct position for both feet.
Timings
After teaching sessions on both skills, 1-min or 30-sec timings as described for the baseline condition were used. The learner could complete as many timings for each skill as he wanted. Initial timings were 1 min for posture and 30-secs for grip. However, timings for posture were decreased to 30 sec after the first session when the learner complained of fatigue trying to maintain posture for that length of time.

RESULTS and DISCUSSION
Charts 1 and 2 (Figure 2 and 3 respectively) present the charted data of the learner’s progress for baseline and intervention on both skills. Chart 1 shows correct and incorrect scores for grip. Baseline assessment showed that the learner gripped the club correctly 6 times and 2 times incorrectly in 1-min. In the first timing after intervention he scored 10 corrects and zero incorrects. His corrects accelerated across subsequent sessions, reaching aim on the 4th session (18). A maintenance check 4-weeks after teaching finished resulted in a further acceleration to 30 corrects and 2 incorrects.

Chart 2 shows the learner’s correct and incorrect scores for posture. Baseline assessment shows the learner assumed the correct posture 7 times and the incorrect posture 3 times in 1-min. The first timing after intervention resulted in 8 corrects and 4 incorrects and corrects continued to accelerate until aim was reached on the third session. A maintenance check after 4 weeks resulted in a further acceleration to 34 corrects and 2 incorrects. During the course of this program the learner’s official handicap dropped from 9 to 7.

These results would suggest that the intervention was successful in improving fluency in achieving correct grip and posture for this learner. The increase in actual game scores further suggests that the improvement in these two components of the golf swing may have had a direct effect on the learner’s swing during games. Once dysfluent components have been identified, repeated practice, instruction, and feedback are low cost, efficient strategies that can improve overall performance.

REFERENCES


Evan’s Frequency of Hand-Biting During a Six-Hour School Day

Philomena Smyth and Nicola Hardy
Behaviour Intervention Services

Evan is a six-year-old autistic boy who is a student in a small school in Ireland. The school employs behaviour analytic principles and utilizes the Standard Celeration Chart to measure student progress. Evan engaged in a high rate of hand biting on a daily basis. Baseline measurements showed that Evan could bite his hand up to 154 times in the six-hour school day.

The school staff conducted a functional assessment on Evan’s hand-biting behaviour to discover possible controlling functions. The results of the assessment identified a number of controlling variables. Evan would meet a number of “frustrating” situations throughout the school day that would occasion hand-biting behaviour. These were generally situations where he was told “No or “Wait” in response to a mand, or where he encountered situations where he needed help and was unable to ask for it. The chart shows Evan’s rate of hand-biting decelerated significantly once he was taught to ask for help when he met difficult situations. The frequency of hand-biting decelerated yet again when Evan was taught to accept the words “No” and “Wait.”

Additional functional assessment identified a function whereby Evan would hand-bite in situations where he was excited (e.g., bouncing on the trampoline). The school staff set up “excited” situations where Evan was likely to hand-bite and taught him more appropriate ways to express excitement. This change resulted in further deceleration of Evan’s hand-biting. The last data point on the chart shows a hand-biting frequency of 2 in a six-hour day.
Teach Help

Redirect "excited" Function

Behaver: Evan

Target: Free/Bite Hand

Successive Calendar Days (by weeks)

Count Per Minute

Functional Assessment Observation

Evan Hand Biting — Standard Celeration Chart
Rick's reading progress

Leah White
The Pennsylvania State University - University Park

Rick was a 7-year-old first grade student that had difficulty with reading. As described by his teacher, he was of average intelligence, but struggled with the grade level curriculum. He enjoyed playing with other students, but didn't like to read during morning center times. Rick could read some sight words such as “here, ball, I, to, go,” and “the.” He could also sound out a few other words, but his reading ability was lower than most of his classmates. He did not know all the letter sounds or phonemes, which led to his inability to sound out words and read in a fluent manner. The goal of the intervention for Rick was to provide instruction and practice with letter sounds and sounding out words, thereby improving his reading ability.

Rick was chosen to receive additional reading lessons from an outside instructor, myself, in his small suburban elementary school in central Pennsylvania. He was selected because he struggled greatly with the reading curriculum. He didn’t have a support network at home to help him catch up and his teacher indicated that the extra help provided by the intervention might get Rick back on track and develop his reading skills.

Methods. To begin Rick's intervention, assessment data was collected to determine areas of greatest need. An informal assessment was given that measured segmenting words into sounds, telescoping sounds in a word, saying letter sounds, blending or sounding out words and saying them fast, reading sight words, and reading connected text or oral reading. The fluency aims for the previous skills appear in Table 1. Rick was fluent with segmenting and telescoping, but struggled with the remaining areas in the assessment. When Rick was informally assessed he knew most of the consonants, but his only consistently produced vowel sound was short /a/. Therefore, his instruction began with see/say letter sounds, specifically vowel sounds.

The instructor worked with Rick for seven weeks. During that time many topics were covered. Rick received instruction on, and practice with, short vowel sounds, words with short vowel sounds, decodable text reading, letter combinations, words with letter combinations, and repeated readings of grade level texts. Each lesson lasted approximately 20 minutes and followed the same format.

The lesson started with instruction in a new topic using a Direct Instruction (DI) lesson with a model, prompt, and check phase (Carnine, Silbert, & Kameenui, 1997). For a sample lesson plan, see Figure 1. After finishing the lesson, Rick completed exercises designed to build fluency. Before the exercises began a digital kitchen timer was set with the given time for each trial and the instructions were read to Rick. The instructions were written on a sheet that was read before each day’s trials. The trials began with the instructor saying “start” and ended with a beep from the kitchen timer. The fluency exercises were practice sheets, a sheet with several letters or words that Rick had to read in a set amount of time. Each sheet had more letters or words than he could read in the set time and he read until time was up. Rick did four practices sheets per day: see/say letter sounds, sight words, and two repeated readings. His trials for the see/say letter sounds were 15 seconds and for the remaining three practice sheets he had 20 seconds per trial. He had four trials per sheet and his best score of the day was recorded on a Daily Standard Celeration Chart. Between each trial on a practice sheet if errors were made, the instructor pointed them out and guided Rick to the correct answer.

Once a week, Rick was also given a Curriculum-Based Measurement (CBM) protocol (Deno, Fuchs, Marston, & Shin, 2001). These protocols measured his oral reading fluency and were chosen before instruction began based on an average end of the year first grade reading level. He read two passages on test day and the best score was charted on the Weekly Standard Celeration Chart. Rick had 20-seconds to read as much as he could and was only given one trial per story.

As reinforcement, Rick used a sticker system. He had a chart with rows of boxes on it. For each day that he did good work, which was defined as completing all the tests without complaining and giving his best effort, Rick earned a sticker to place on his chart. At the end of each session Rick and the instructor decided whether he had tried his best and the chart was full he was able to trade the chart in for a large prize (i.e., a pack of Pokémon cards).

Results. On the see/say letter sounds chart (Figure 2), Rick progressed from a 16-letter sound practice sheet, to 32-letter sound practice sheet, to finally reaching fluency in all 40 letter sounds or phonemes. On the 16-letter sound sheet Rick’s corrects increased at a celeration of x 1.3 and his errors decreased by a celeration of ÷1.9 until he met his aim. Then Rick received a new sheet with 32 sounds on it. On the new practice sheet Rick met
Objective: The student will correctly say 3/3 words with letter combinations on 3 or more days.

<table>
<thead>
<tr>
<th>Instructional Strands</th>
<th>Monday 4/22/02</th>
<th>Tuesday 4/23/02</th>
<th>Wednesday 4/24/02</th>
<th>Thursday 4/25/02</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acquisition</td>
<td>&quot;ea&quot;</td>
<td>&quot;ch&quot;</td>
<td>&quot;oy&quot;</td>
<td>&quot;qu&quot;</td>
</tr>
<tr>
<td></td>
<td>M – each, eat</td>
<td>M – chick, choose</td>
<td>M – boy, ploy</td>
<td>M – quick, quiet</td>
</tr>
<tr>
<td></td>
<td>P/C – beat, beach, seat</td>
<td>P/C – chin, chant, chew</td>
<td>P/C – toy, soy, joy</td>
<td>P/C – quiz, quit, quill</td>
</tr>
<tr>
<td>Maintenance</td>
<td>Story Reading: Story 14</td>
<td>Story Reading: Story 15</td>
<td>Story Reading: Story 16</td>
<td>Story Reading: Story 17</td>
</tr>
<tr>
<td>Sight Word List</td>
<td></td>
<td></td>
<td>Sight Word List</td>
<td>Sight Word List</td>
</tr>
<tr>
<td>Repeated Reading 3</td>
<td></td>
<td></td>
<td>Repeated Reading 3</td>
<td>Repeated Reading 3</td>
</tr>
<tr>
<td>Repeated Reading 4</td>
<td></td>
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<td>Repeated Reading 4</td>
</tr>
<tr>
<td>Assessment</td>
<td></td>
<td>Curriculum Based Measurement 15</td>
<td>Curriculum Based Measurement 16</td>
<td></td>
</tr>
</tbody>
</table>

Note: M = Model: teacher demonstration
P/C = Prompt/Check: student completed with fading assistance
the fluency aim and his errors continued to decline. The celeration was \( x = 1.7 \) for corrects and \( ÷ 2.8 \) for errors. On the last sheet, which had all 44 phonemes, Rick met fluency and maintained his aim of 100-150 letter sounds per minute on three consecutive days with an acceleration of \( x = 1.0 \) for corrects and a deceleration of \( ÷ 1.0 \) for errors.

On the sight word practice sheet (Figure 3), Rick moved from a sheet with only short /a/ words to a sheet with words containing all the short vowel sounds. Rick didn’t meet fluency on the short /a/ sheet before moving on, but was close to his aim at that time. His corrects improved at a rate of \( x = 3.3 \) and his errors diminished at a rate of \( ÷ 1.6 \) on the short /a/ sheet. These trends continued on his new sheet with all the vowel sounds and Rick neared fluency as the seven week instructional period ended. His corrects accelerated at \( x = 1.3 \) and his errors declined at \( ÷ 1.55 \).

Rick moved forward with the repeated readings during the intervention as well. On his first story he met his aim in three weeks, with his corrects increasing at \( x = 1.3 \) and his errors decreasing at \( ÷ 1.8 \) (Figure 4). This pattern was present on the third story too, with a rapid acceleration in corrects at \( x = 9.0 \) and a deceleration to no errors at a rate of \( ÷ 4.0 \).

The last set of repeated readings showed the same progress (Figure 5). His corrects improved at \( x = 1.5 \) and his incorrects declined at a celeration of \( ÷ 2.2 \), until meeting the aim of 150-250 words per minute on the second story. On the fourth story Rick’s trend was generally upward for corrects with an acceleration of \( x = 10.0 \) and a deceleration in errors at a rate of \( ÷ 7.8 \).

The CBM showed an overall improvement in correct words read per minute and a steady number of errors made on each story over the interventional period (Figure 6). Rick’s celeration for corrects was \( x = 1.25 \) and his error celeration was \( x = 1.0 \).

**Discussion.** Rick was a first grade student who enjoyed coming to school. However, after five months of instruction in a general education classroom he was unable to read at an appropriate grade level. While many of his classmates were reading short stories, Rick was unable to even sound out short words. He realized his classmates were doing better than he was and yet he couldn’t read, no matter how hard he tried.

The instructor was asked to do an intervention to give Rick the skills that would enable him to read and catch up with his classmates. The instructor chose to use parts of three research-based procedures: Direct Instruction (Carnine, Silbert, & Kameenui, 1997), Precision Teaching (Lindsley, 1990), and Curriculum-Based Measurement (Deno, Fuchs, Marston, & Shin, 2001). After seven weeks of additional instruction in the basic skills necessary for reading, such as letter sounds and sounding out words (Carnine, Silbert, & Kameenui, 1997), Rick was able to read decodable text. He became fluent with these skills and generalized them to settings outside the intervention sessions. For example he would use them in class reading centers and when working with other adults.

Rick improved greatly in the see/say letter sounds and sight word practice sessions. His scores steadily rose as shown in Figure 2 and Figure 3. His ability to do repeated readings also increased dramatically throughout the interventional period as show in Figure 4 and Figure 5. However, the ultimate goal for the intervention was to give Rick the skills necessary to read. Teaching him the basics provided the foundation for his reading ability to develop. His skills for reading words in context showed remarkable progress as depicted in his weekly CBM scores (Figure 6). These scores recorded Rick’s ability to read grade level texts and are solid evidence that Rick learned to read using the methods described above.

Rick’s reading ability quickly accelerated during the intervention. He went from a child that didn’t enjoy reading and would rather play with Pokémon cards to one who did extra trials and timed himself to see how far he could read. The best effect of the intervention though was on the last day as book order forms were being passed out. Rick looked at the instructor and said, “I’m going to ask my dad to get me some books because I can read them now.” And you know what, he was right.
REFERENCES


Tracking Curricular Progress with Precision

Michael A. Fabrizio, Kristin Schirmer and Kelly Ferris

Fabrizio/Moors Consulting

When using any piece of structured curriculum it is often important to assess the rate students are progressing through that curriculum. Progress that is too fast may indicate that the student is ready to be moved to a more challenging curriculum or to a higher level within the existing curriculum. Progress that is too slow may indicate the presence of dysfluent component skills in need of redress or that another curriculum should be considered.

The chart, Figure 1, is an example of how we monitor the progress students make through Direct Instruction curricula. The chart represents Jon’s progress. Jon was 10 years, 2 months old when he began working in the Comprehension B2, a 65 lesson corrective reading program targeting comprehension skills. Each lesson of Comprehension B2 is composed of 8-10 exercises. Jon worked in the curriculum daily during one on one instruction with his therapist, Kristin Schirmer. Jon was fully included in a general education fourth grade classroom for the remainder of his school day. The dots on the chart show the cumulative number of exercises completed within the curriculum, and the X’s show the number of exercises completed per day.

As Jon’s curricular needs changed, the amount of time he worked in Comprehension B2 changed as well. Initially, he worked in the curriculum for 10 minutes. This amount of time varied, ranging from 10-minutes to 30-minutes daily. Across all the days of timed practice on the chart, Jon was allowed to skip an exercise in a lesson if, in the previous lesson, he completed that same exercise with no errors. As an example, if Jon completed exercise 3 of lesson 42 with no errors, he would skip that same exercise in lesson 43 and complete it again in lesson 44. This skipping procedure helped ensure Jon spent his time working on the parts of the curriculum that were difficult for him, while still ensuring he contacted the exercises frequently as they became more and more complex. It also provided an incentive for applying himself to each task. The better his performance, the fewer tasks he had to do in the subsequent lesson.
\* = cumulative number of exercises completed
\(\bigcirc\) = exercises completed per day per minute

M. Fabrizio  K. Ferris  K. Schirmer

Jon 10.2 Asperger's

Teaching Visual Pattern Imitation to a Child with Autism

Michael A. Fabrizio and Kristin Schirmer
Fabrizio/Moors Consulting

Learning to recreate patterns they see is an important skill for children to learn. Well-developed visual patterning skills can be useful in learning to play games such as Connect Four™ and Candyland™, in playing with building toys such as Legos™, completing some in-class assignments such as parts of worksheets, and even learning to cook by following picture cue steps in a recipe. This learning to play games such as Connect Four™ and Candyland™, in playing with building toys such as Legos™, completing some in-class assignments such as parts of worksheets, and even learning to cook by following picture cue steps in a recipe. This chart shows the progress one youngster with autism made in learning to reproduce patterns of colors.

When the chart began, Max was 5-years and 1-month old. He had a diagnosis of mild autism, and was slated to begin public school by spending half of each school day integrated into a general education kindergarten classroom and half of each day in a self-contained classroom for primary-aged children with developmental disabilities. Max could speak and would often request things and actions as well as label items in his environment. He spoke in 2-3 word sentences, and had particular difficulty with the syntax of spoken language such as making pronoun and verb tense errors. He could label many colors expressively and receptively, as well as numbers, letters, objects, and people.

Max began timed practice on See/Do Pattern Imitation on August 12, 2002. Initially, he practiced reproducing a pattern consisting of 2 colors. His therapist presented him with a sheet of paper showing colored blocks arranged in pattern sequences. For the first slice, 2 color patterns, each sequence consisted of 2 colors (e.g., red-blue-red-blue, green-green-yellow-yellow). Max's therapist handed him large Lego™ blocks, which he used to reproduce the pattern. Because the first slice listed on the chart required that no distractor blocks be used, Max only had colored Legos™ consisting of the colors presented in the patterns. He had the exact number of Legos™ he needed to complete the patterns. Max used different pattern sheets for each day of practice across all phases of this chart.

Each day he practiced, Max's therapist set a daily improvement goal that he needed to reach to stop practice for the day and earn a special reward such as playing with a preferred toy with his therapist. Max completed 30-second timings, during which his therapist showed him the sheet of patterns he was to copy and handed him the blocks he needed in order to copy the patterns. As he was completing one pattern, his therapist handed him the set of blocks he needed for the next pattern on the sheet. The movement cycle counted was each block moved into place within a pattern. If Max saw the pattern red-blue-red-blue, and positioned all the blocks in the correct order, he received credit for four correct movements. If he saw the pattern yellow-yellow-red-red and positioned the blocks so that they were arranged yellow-red-yellow-red, he received credit for 2 correct (the first and the fourth) and 2 incorrect (the second and the third) movements.

During the first slice of the chart (patterns consisting of 2 colors with no distractor blocks), Max practiced between 2 and 5 times per day. His corrects accelerated at X1.7 per week, and errors ranged between 0 on most days and 6 per minute. When his corrects reached 50 per minute, the slice changed to a pattern consisting of 2 colors with Max having all the blocks he needed and one he did not need to complete the pattern (1 distractor). His performance jumped down slightly during the first day of this phase, but accelerated at X1.9 to a high of 60 correct movements per minute with 0 errors on the third day of practice. He required 3-4 practices per day during this phase.

Because his performance did not jump down much when we introduced the 1 distractor block, and he surpassed his previous best performance within 3 days of timed practice, we made the task considerably more difficult by presenting Max with patterns consisting of 2 colors, but giving him 8 blocks to use to replicate the pattern – 4 blocks he needed for the pattern, and 4 blocks he did not need. This was the "2 color pattern, 4 distractors” phase of the chart. His rate of correct movements per minute jumped down to 42 on the first day of timed practice, and accelerated at X1.15 across 12 days of practice in 3 weeks to a new high of 80 movements per minute. When we first started the phase, his errors jumped up to 8 per minute but then jumped down to 0 per minute for most days of the phase. He completed 2-5 timings per day throughout this phase of the chart.

Max’s family took a vacation for two weeks. When they returned, we increased the task difficulty by using patterns consisting of 4 different colors and giving Max all the blocks he needed to replicate the pattern plus an additional 4 blocks he did not need. His frequency of correct performance accelerated from an initial jump down value of 28 per minute to an ending frequency of 60 per minute at a slow celeration of X 1.05. This slow progress was probably due to inconsistent practicing. Where in previous phases, Max practiced this skill 3-5 times per week, in this phase he practiced an average of twice per week. Throughout the phase, he required 2-5 practices to meet his improvement goals.
Following the patterns with 4 colors and inclusion of 4 distractor blocks, we began checks to evaluate the outcomes associated with fluent performance (retention, endurance, stability, and application). To evaluate Max’s performance for endurance, we tripled the length of the original timing interval and presented Max with the same materials he used during the last phase of timed practice. His performance dropped slightly across the course of the 90-second timing, so we went on and performed the next evaluation. After the endurance check, we had Max complete timing for 30-seconds while in the presence of significant distractions. For Max, this involved doing the timing upstairs with his mother, father, sister, and brother walking around the house and the television playing one of his favorite movies. Max’s performance passed the stability check, so we proceeded with an application check. For the application check, we presented Max with all new color patterns he had never seen and had him complete a timing. He readily performed the task, matching his performance from the last phase of timed practice. Finally, to assess skill retention, we stopped all timed practice on this skill for 4 weeks. After 4 weeks (the data would not fit on the chart), we presented Max with the materials from the final slice of the timed practice portion of the chart (4 color patterns with 4 distractor blocks), and had him complete a 30-second timing. He matched his previous performance on the first timing, so we stopped the chart and had a little celebration.
Anna's first stroke was in August of 1999 and her second stroke was one year later. She lived in her hometown nursing facility in Idaho, three hundred miles from my home near Seattle. The Idaho staff notified me immediately upon the onset of those strokes.

Those strokes paralyzed Anna's left limbs. The strokes took additional toll on her memory, as well, but her speech remained intact. The Idaho staff described Anna's stroke recoveries as mostly sleep and depression the first two days, or so, and within a week, back to her usual gregarious state.

I brought my mother to a nursing facility close to my home in June 2001. My wife and I visited my mother after supper each evening. We would share photos and play dominoes with her. On February 21, 2002, we arrived to find her in bed and asleep--then an unusual event.

The following evening we found Anna in the main dining room in her wheelchair totally bewildered. She knew nothing of dominoes. Her expressive language skills were gone and receptive language questionable. Clearly Anna had her third major stroke. This nursing home staff was unaware. The staff members were unaware, not because they did not care, but because there was no consistency in patient assignments. Staff observations were infrequent and too far apart to note change.

Not only were staff members insensitive to Anna's changes, the facility's data collections were obtuse and confusing. A copy of the facility's meal tally-sheet shows blank no-entries, zeros for refusals, hyphens for food not served, and fractions for partially eaten portions that vary in serving size. Numbers in cubic centimeters (cc's) show fluids consumed. All this recorded in day columns and meal, food, and drink rows that form 1,147 boxes on an 8 1/2" X 11" sheet of paper. No change pictures are quickly seen from these observations, either.

Frustrated by the nursing facility procedures and measurement systems, I fed my mother at most meals and recorded her intake in cc's on the Standard Celeration Chart (SC Chart). I charted solid intake on one SC Chart, fluid intake on one SC Chart, and total intake on a third SC Chart. Anna's puree solids SC Chart was the most sensitive of the three.

Anna's fourth stroke occurred during SC Chart week 17. Week 17 shows Anna's eating to be an Instant /500 drop day to zero cc's; a four-day X8,000 celeration recovery; and then a return to average eating. These charted data matched Anna's first two stroke behavior recovery descriptions cited by her Idaho nursing staff; and by my own descriptive observations of Anna's third stroke. Anna's fourth stroke eating picture retrojected her first three stroke eating pictures; and provided us with a picture of her stabilizing.

Update. Anna's fourth stroke hit her language areas again leaving her able to communicate only the most basic one to three-word commands. Strokes three and four also increased her need to sleep.

The nursing facility maintains no recorded evidence of Anna's having strokes three or four.

Anna's physician requested all three eating and drinking SC Charts. The doctor wanted some stroke indication in her professional files.

Addendum. One other observation that should not be over-looked in this chart. Anna took Prilosec for acid reflux, vitamin C tablets, and iron supplement for a number of years. SC Chart weeks 6 to 12 shows Anna's puree eating in cc's while taking the prescriptions. For a number of reasons, the prescriptions were discontinued on Thursday of week 12. The data during weeks 12 through 16 shows Anna's puree intake after the discontinuance. The data are a X1.8 step-up and a X1.1 turn-up from the data weeks of 6 to 12. The prescriptions were suppressing Anna's eating.
(✓) Ate all, (0) Refused, (-) not served.  Partial Portions: Record amount eaten (1/4, 1/2, 3/4)

|          | 1  | 2  | 3  | 4  | 5  | 6  | 7  | 8  | 9  | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 30 | 31 |
|----------|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|
| Breakast |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
| Fruit    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
| Cereal   |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
| Egg/Main (Protein) | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Bread/Butter |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
| Milk (cc) |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
| Juice (cc) |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
| Beverage (cc) |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
| * Katie Jello | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| * Replacement taken (cc) | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| LUNCH | (Initials) |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
| Fruit |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
| Soup |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
| Meat/Main (Protein) | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Starch (Potatoes, Rice, Pasta) | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Vegetables |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
| Bread/Butter |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
| Dessert |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
| Milk (cc) |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
| Juice (cc) |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
| Beverage (cc) |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
| * Katie Jello | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| * Replacement taken (cc) | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| DINNER | (Initials) |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
| Fruit |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
| Soup |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
| Meat/main (Protein) | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Starch (Potatoes, Rice, Pasta) | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Vegetables |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
| Bread/Butter |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
| Dessert |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
| Milk (cc) |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
| Juice (cc) |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
| Beverage (cc) |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
| * Katie Jello | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| * Replacement taken (cc) | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
* NOTE: Offer replacement if less than 3/4 meal taken.

NAME: Nesty Anne
PROBLEM: 802 3/01
Single vs. Multiple Movement Frequencies:  
How Many Times Should We Measure?

Dana J. Stevens  
University of Washington

The purpose of this chart share is to look for more efficient ways of monitoring a learner’s progress. I decided to compare progress records based on a single opportunity to complete complicated task with a progress record based on multiple opportunities to complete the same task.

The learner, Sam, was an 8-year-old boy with autism who was fully integrated into a regular 2nd grade classroom. The goal of this intervention was to teach Sam how to put on his coat independently. To begin, a 12-step task analysis was created and the method of most-to-least prompting selected. During the course of the program, a picture script of the task analysis and peer modeling methods were also used. Instruction took place during naturally occurring school opportunities to put on his coat (e.g., preparing to go outside for recess, preparing to go home for the day). Sam’s parents also worked with him at home using the same task analysis.

Three methods of monitoring the learner’s progress (Figure 1) were implemented throughout the program: (1) Single-movement frequencies involved charting a single opportunity to complete the task each day. Time to completion was recorded and additional prompts were counted as errors. (2) Multiple-movement frequencies were also recorded daily and involved charting total opportunities and the cumulative time to complete putting on his coat across all opportunities. (3) Weekly parent reports were conducted to evaluate the family’s satisfaction with their son’s skill development.

Single and multiple-movement frequencies showed similar rates of progress and occasioned the same instructional decisions, so it appears that a little effort could have been saved by evaluating his progress only once each day. That may not always be the case, however, so I’d recommend that single and multiple-movement frequencies both be charted when beginning a program. If the two charts show the same learning picture, the multiple-movement chart could be dropped to save time and effort. If the two pictures are different, you might want to keep the multiple-movement chart to get a more complete picture of learning.

In addition, I was pleased to note that the parent’s report of his progress at home confirmed that he had learned something useful and was using his new skill in places where it was important. It is my recommendation to gather the same type of feedback whenever possible.

For the Single Movement Frequency:

\[
\text{Correct Frequency} = \frac{1}{\text{Time Required to Complete the Task Once}} \times \frac{\# \text{ of Extra Prompts}}{\text{Error Frequency}} = \frac{\text{Time Required to Complete the Task Once}}{\text{Cumulative Time Required to Complete All 3 Trials}} \times \frac{\# \text{ of Extra Prompts}}{\text{Cumulative Time Required to Complete All 3 Trials}}
\]

Figure 1: Three methods of monitoring the learner’s progress
Owen White  Dana Stevens  S.B.  8 years  Autistic
Name of School  School Staff  School Staff  Dana  Coat-On & Extra Prompts
Many methods exist for you to present information to others. You can render verbal descriptions of the information. You can quantify the information and give to others the numbers. You can sort and put the numeric information into tables. And you can illustrate the information by way of picture or graphic. Each method has its strengths and weaknesses, depending on how you apply the method. Many of us quantify information, and find it expedient as well as useful to illustrate the information. Accordingly, we resort to using charts and graphs, or other types of diagrams or figures. The basic idea is to convey information to others so that we communicate effectively to them.

Charts, graphs, and even tables of numbers as well as verbal descriptions all serve as discriminative stimuli. The concept of "discriminative stimulus" comes from behavior analysis. Basically, it refers to some object or event that precedes a behavior in time. A discriminative stimulus also, in a loose sense, represents a sign or signal to the person to take some action or to make some decision. Charts, graphs, and other figures can help our reasoning when we need to interpret information. They can assist us in making decisions based on the information. They can instruct others about what we discovered. But charts, graphs, and other figures can also distort information, conceal information, or be used for persuasion instead of honest interpretation. Charts constructed for persuasive purpose may deceive people. They may make us commit errors in our reasoning. They may lead us to make poor decisions.

What forms the essence of science? To a large degree, science consists of how you collect information and then put it together so that it may be interpreted productively. You need to collect the right information. The information will likely include measures and quantities, which will allow you to make comparisons and decisions. You need to make sure that when you quantify information that you do so in the most clear, honest way possible. This means selecting measures that tell us something useful about what it is you are measuring. Are you measuring trends? Are you comparing values? Do you want to see the effect of changing the values of an independent variable? Do you want to see how people, behaviors, or events distribute themselves? If so, then you need the right units of measure.

Having the right measures helps, but it helps further to view these measures so you can reason well about what they indicate, and to make decisions based on them. While a series of numbers may indicate a trend, a trend may be better depicted as an angled line. Hence, a chart of those numbers works well to let us view the trend, and does a better job than the numbers. You can see at a glance whether a line is angled upward, flat, or downward. Putting numeric measures onto a chart or graph represents, then, the visual display of quantitative information.

Nearly 20 years ago Edward R. Tufte published a book dealing with the visual display of quantitative information. He analyzed what makes for a good display, and singled out practices that lead away from good displays. What makes a chart useful and helpful to the reader? What leads the reader astray? What are the do's and don'ts of charting? These questions form the topic of Tufte's book, one that skilled Precision Teachers and researchers will find highly valuable. For the person interested in deep issues concerning graphical display of quantitative information, Tufte's book provides invaluable background information. It can also serve as a guide for us to check up on our own practices. Is the Standard Celeration Chart, by itself, good at helping the visual display of quantitative information? Can we misuse the chart? Can we lower its effectiveness? Can we use it to persuade people about something we advocate? Can we conceal what happened? Armed with Tufte's book, we can address these issues and concerns.

Tufte divided the book into two main parts: Part 1 deals with "Graphical Practice," and covers the topics of graphical excellence, graphical integrity, and sources of graphical integrity and sophistication. Part 2 deals with the "Theory of Data Graphics," and covers the topics of data-ink and graphical redesign, chartjunk: vibrations, grids, and ducks, data-ink maximization and graphical design, multifunctioning graphical elements, data density and small multiples, and aesthetics and techniques in data graphical design.
Excellence in Graphics

Tufte begins the chapter on Graphical Excellence by commenting: "Excellence in statistical graphics consists of complex ideas communicated with clarity, precision, and efficiency." This forms a useful working definition of excellence. It indicates, perhaps, a goal we should strive for when we use charts. Tufte next identifies nine criteria of excellence in graphics used to display quantitative information. He states that "Graphical displays should:

- show the data
- induce the viewer to think about substance rather than about methodology, graphic design, the technology of graphic production, or something else
- avoid distorting what the data have to say
- present many numbers in a small space
- make large data sets coherent
- encourage the eye to compare different pieces of data
- reveal the data at several levels of detail, from a broad overview to the fine structure
- serve a reasonably clear purpose: description, exploration, tabulation, or decoration
- be closely integrated with the statistical and verbal descriptions of a data set." (page 13).

Without exception, the Standard Celeration Chart (Pennypacker, Koenig, and Lindsley, 1972) has the potential to meet all of Tufte's criteria for graphical displays. The cumulative record as developed by B.F. Skinner, an early staple of behavior analysis, meets those same criteria as well. Both of those charts are standard charts, having standard dimensions, whereon the "meaning" of dots and lines always runs with respect to particular standards. For instance, on the Standard Celeration Chart a line drawn from bottom left corner to top right corner has an angle of 34 degrees, which always represents a celeration of X2 (read as "times two."). Any line parallel to that standard also has a celeration value of X2. A grid of "standard celerations" can be drawn for reference celerations; typically this grid includes reference celerations for X4, X2, X1.5, X1.25, X1.1, and X 1.0. Similarly, the cumulative record, which Lindsley has described on several occasions as a "standard frequency chart," also has standard reference grids. These grids used to be part of the visual display in older publications. A certain angle would be a frequency or rate of 1 per minute. An angle somewhat steeper would reference a rate of 2 per minute. A yet steeper line, about the same angular distance as from 1 to 2 would reference 4 per minute, and so on. In addition, both charts show data of measures that are at once universal, standard, and absolute measures.

Both the Standard Celeration Chart and the Standard Frequency Chart (cumulative record):

(a) show the data
(b) induce viewers to think about the substance of the graphic rather than the methodology of graphic production or design
(c) clearly avoid distorting what the data say
(d) present many numbers in a relatively small space
(e) make large data sets coherent
(f) encourage the eye to compare different pieces of data (indeed, compel such comparisons)
(g) reveal the data at several different levels of detail (e.g., the Standard Celeration Chart simultaneously illustrates frequencies, but also celerations, and variability, cycles and various trends; the Standard Frequency Chart similarly illustrates local rates and overall rates.)
(h) serve a very clear purpose, which is to show precisely and unambiguously a clear record of behavior and behavior change, thereby permitting not only precise and reliable description but also allowing for exploration. In the case of the Standard Celeration Chart straight line celeration predictions can be made.
(i) both charts are very closely integrated with the statistical and verbal descriptions of the data sets.

In the case of the Standard Frequency Chart (cumulative record) in particular, the angled lines and tick marks often ARE the data set. Typically, precision teachers do not make statistical transformation or conversion from numbers to graphics. Instead, they record the data directly and continuously as dots on the Standard Celeration Chart.
In contrast, most of the time the various other charts and graphs used in behavior analysis violate Tufte's suggested standards of excellence. Or if they do not violate these standards they may fail to meet them. Often, many behavioral researchers ignore several of Tufte's standards at the same time. Within the same publication the same data may be put on charts with different axes, but where the grids have the same physical dimensions. Axes may be stretched or compressed on either or both dimensions, thereby changing how the plotted data will look. Small effects may appear magnified. Large differences may appear muted. Some results such as trends or variations in the data may not show up at all. Sometimes the variations in design of behavior analytic charts unnecessarily induces viewers to spend time figuring out what the chart attempts to show.

Researchers may ignore Tufte's suggested standards of excellence for many reasons. These may have to do in part to a lack of awareness with respect to those standards. Researchers or scholars may not have been educated in the issues and problems related to graphic display. It may also reflect the operation of various macrocontingencies operating at the cultural or institutional level. Common and accepted practices for particular professions, including applied behavior analysis, may select against and thus discourage any effort to meet any of Tufte's standards. This may be especially true if there are political or economic contingencies operating that may affect how data are displayed graphically. This may even be true on a subtle level. For instance, a chart that magnified a small effect may help toward publication of an article. To what extent such macrocontingencies exist and play any role can only be speculative at this point, and is beyond the scope of this mini-review--though it may prove an interesting investigation.

**Integrity**

Tufte's second chapter, on Graphical Integrity, seems more interesting than chapter one, in my opinion. Tufte begins chapter two by observing, "For many people the first word that comes to mind when they think about statistical charts is "lie."" (page 53). This forms a key issue. Tufte adds that "a graphic does not distort if the visual representation of the data is consistent with the numerical representation." (page 55). From these observations Tufte introduces the "Lie Factor"--a valuable concept curiously overlooked in Iver Iverson's (1988) review of Tufte's book in the Journal of the Experimental Analysis of Behavior. Tufte's formula for the Lie Factor appears relatively simple:

\[
\text{Lie Factor} = \frac{\text{size of effect shown in graphic}}{\text{size of effect in data}}
\]

In his chapter Tufte presents several classic examples of severe Lie Factors. For instance, he presents a graph published in the New York Times (August 9, 1978) pertaining to fuel economy standards based on Congressional and Department of Transportation data. These were standards that car manufacturers would have to meet. The data set began with 18 miles per gallon in 1978, and incremented to 19 in 1979, 20 in 1980, 22 in 1981, 24 in 1982, 26 in 1983, 27 in 1984, and 27.5 in 1985. The chart of these data in the Times, however, was drawn as perspective of a highway extending to a vanishing point in the distance, Imagine a perspective drawing of a highway, with the angles of the edges of the road converging and meeting in the distance. The drawing even included shading and the typical dashed lane marker lines characteristic of roads. On this chart the fuel economy standards were drawn as horizontal lines from one side of the road to the other. The line for 1978 was drawn in the distance, near the vanishing point. The lines for subsequent years were drawn down the chart, so that the line for 1985 was near the bottom of the chart. The long and the short of it, so to speak, was that the line for 1978 was 0.6 inches long, whereas the line for 1985 was 5.3 inches long.

The increase in the raw data is computed as 27.5 - 18.0 / 18.0 X 100, which equals 53%. Over that span of time fuel standards would increase 53%. However, as Tufte notes, "the magnitude of the change from 1978 to 1985 is shown in the graph by the relative lengths of the two lines:"

\[
\frac{5.3 \text{ inches} - 0.6 \text{ inches}}{0.6 \text{ inches} \times 100} = 783\%.
\]

Visually, then, the graph compels an interpretation of a 783% increase in fuel standards, while the actual data denoted a 53% increase. Tufte then computed the Lie Factor for this chart:

\[
\text{Lie Factor} = \frac{783}{53} = 14.8
\]

In other words, the New York Times' graph lied about the data by a factor of 14.8 times.

Since a picture is worth a thousand words, the point becomes much more clear if you can see the graph that Tufte uses for an example, rather than to try to visualize it from the words written.
An interesting research task would be to ascertain how widespread lie factors are found in behavioral research graphical data presentations. With standard charts you are unlikely to find lie factors, of course. But with the tendency for behavioral researchers to draft their own charts and graphs the possibility for lie factors certainly presents themselves.

Tufte adds that the ideal Lie Factor has a value of 1, which means the size of the effect shown in the graphic matches the size of the effect in the data. He’s not absolutely strict, however, and suggests that the range of Lie Factors from .95 to 1.05 are probably acceptable, and include minor inaccuracies in plotting. Tufte suggests that "The logarithm of the Lie Factor can be taken in order to compare overstating (log LF > 0) with understating (log LF < 0) errors" (page 57). He adds that most such distortions are those of overstating; that Lie Factors as big as 5 are relatively common.

When I first read about Tufte’s concept of the Lie Factor I immediately thought of Og Lindsley’s frequent commentary about “fill the frame” charts, also known as “stretch to fill” charts. Og corrected me by saying that “stretch to fill charts” are not indicative of Lie Factors per se. Og came up with the terms “stretch to fill” and “fill the frame” in response to a general tendency of behavioral researchers to draw graphs where they “stretch out” or compress the chart axes in order to fill up the resulting frame with their data. The researcher stretches or compresses one or both of the axes of a chart such that a particular effect is illustrated. By stretching the vertical axis a small effect can be made to appear larger. By compressing an vertical axis a large effect can be made to look smaller. Likewise, stretching a horizontal axis can “attenuate” a trend, giving it a lower angle.

Stretching an axis and filling the frame can produce differences to interpretation of results. Porter (1985), for instance, discovered that about one-third of the effects published in the Journal of Applied Behavior Analysis were counter-turns. A counter-turn occurs either when a frequency jump up is followed by a celeration turn-down, or a frequency jump-down is followed by a celeration turn-up. Either way, the behavior heads back towards its baseline level. The effect is only transitory, in other words. Porter discovered these counter-turns when recharting behavioral data onto Standard Celeration Charts. The effects were either invisible or at best barely noticeable in their original charts. Whether the researchers created charts to conceal the counter-turns remains unanswerable, but the outcome is the same. By the way the chart is drawn the reader may not notice the counter-turn and may therefore not conclude that the procedure investigated has an effect potentially at variance to what is claimed.

Related to stretching axes is the practice of truncation, where only a segment of an axis is shown. This segment, of course, can then be stretched out to fill the vertical or horizontal space on paper. Stretching and truncation are issues that Tufte deals with in a section of chapter two titled “Context is Essential for Graphical Integrity.” What this means is that charts that have had axes manipulated to show certain results in a certain way are at the very least deceptive to the extent that vital contextual information is removed or distorted.

One of the key features of the Standard Celeration Chart is that it avoids both stretching of axes as well as truncation. Thus, context is always preserved. Now, often data on the Standard Celeration Chart will not cross all six logarithmic cycles. The Chart captures frequencies from .001 per minute (about once per day) in the lowest cycle up six cycles to frequencies of 1000 per minute (a X 1,000,000 differential). Because few behaviors ever traverse all six cycles there may be a tendency to regard the unaffected cycles as superfluous, and hence worthy perhaps of being dispensed with. Under such a tendency there would be a further tendency to stretch out the remaining axes to fill the space left by the excised axes. That, of course, would defeat the purpose of having a Standard chart, as well as violate Tufte’s admonition against removing context. In any event, even the blank cycles provide useful context in that they help locate the frequencies of behavior on a standard frequency scale. To help make the point, think of the location of the visible light portion of the electromagnetic spectrum and the value of including the whole spectrum for contextual purposes. If all you showed was that portion of the spectrum pertaining to visible light the viewer would not be able to tell where it stood with respect to other types of EM radiation. Context is valuable.

**Tufte’s Theory of Data Graphics**

The second part of Tufte’s book covers his theory of data graphics. Here, he discusses vital issues such as "data ink," "chartjunk," multifunctioning graphical elements, data density, and finally aesthetics and technique in graphical design. Only some of these issues concern standard celeration charting. Furthermore, many of these issues will pertain primarily to published charts,
not necessarily to those used on an everyday basis as working charts.

Data-Ink

In the chapter on Data-Ink Tufte presents another valuable ratio: The amount of ink used to make a graphic that presents data or information. Ink that does not present data or information is not considered to be data-ink. Note that the word ink already suggests something that has been published or made ready for archival purposes.

The data-ink ratio equals the amount of data-ink divided by the total ink used to print the graphic. As he suggests, one way of viewing this ratio comes from how much of a graphic you can erase without loss of data or information. Because precision teachers use commercially manufactured charts, the data ink issue may be of marginal concern: People use the same charts and have no need to draw their own. Moreover, working charts build up a data-set over time. Thus, a chart with a lot of unused lines and unused space may seem, at first, to have a poor data-ink ratio. But as days proceed and frequencies charted, this ratio would surely change.

The data-ink issue may have more relevance when precision teachers present or publish their results. At chart shares at ABA conventions speakers sometimes use the transparency templates. Some do not, however. Some people simply show the data without any grid, which exemplifies the point that Tufte makes regarding data-ink. Likewise, in our publications our published charts rarely show the internal up and down day lines or the horizontal frequency lines. Indeed, removing this mass of data-ink actually helps viewing the data.

Chart Junk

Chart junk, as best I can tell from reading the chapter, concerns various decorations or additions made to charts. Such charts become cluttered. They may produce unintended optical effects, too, such as Moiré patterns. Again, Tufte approaches the issue from the point of view of people creating their own charts.

In precision teaching a blank Standard Celeration Chart will contain no chart junk. Is it possible to add chart junk to our charts? Possibly so. Some people add keys, bulleted information, window boxes of explanations, etc., inside the grid area of Standard Charts. This makes use of the empty space that may well be likely on many standard charts. For convention presentation purposes this may be fine, if it lets one combine talking points with visually-displayed quantitative information. However, for publication purposes, and indeed for certain key points when presenting charts, our best practices may be to reduce or eliminate the amount of this potential chart junk.

Data Density and Aesthetics

The final chapters of Tufte’s book cover how much data are shown on a graphic and to what extent one should take artistic sensibilities into account when developing a chart. For data density Tufte offers yet another one of his many ratios. The data density equals the number of entries in a matrix divided by the area of the graphic. The aesthetic issues concern the design of the graphic, the selection of letters and numbers used, the balance and proportion of scale, the professionalism of the drawing and the avoidance of chartjunk decorations. Again, in both cases I regard Tufte’s suggestions as strategic considerations for properly communicating information without exaggerating or minimizing claimed effects. For precision teachers who use manufactured Standard Celeration Charts, what Tufte suggests in these chapters may prove only of marginal significance. Precision teachers do not have to draw their own charts.

Regarding Standard Celeration Charting

While Tufte’s book may have mixed significance overall for precision teaching, the general suggestions he brings up are instructive. The whole point of having a chart is to communicate information. Moreover, it is to communicate effectively; to induce the reader to make certain conclusions. Toward that end, Tufte’s suggestions can assist people who share charts.

For precision teaching the general guidelines covered in Tufte’s book can help us clarify what makes for a good chart. Following Tufte’s guidelines, a properly developed Standard Celeration Chart will:

1. have dates filled out in the blanks across the top;
2. have the labels filled in across the bottom of the chart;
3. have a pinpoint specified in its appropriate blank;
4. have frequency dots that are dark enough, large enough, and otherwise discriminable;
5. have one or more celeration lines drawn through a series of frequency dots;
6. have a straight-line projection of the celeration;
7. have a celeration line that is also dark and thick enough to be easily seen;

8. not have a whole lot of extraneous text, bulleted points, or other items or markings within the chart frame; and

9. not have either of its axes truncated or laminated in order to "fill the frame."

There are exceptions to some of these suggestions, of course. A chart may have a collection of celerations, and thus in that instance adding in the frequency dots will produce confusion. Likewise, a chart may display a series of conditions, starting with a baseline, and thus there should be both vertical lines separating the different conditions, along with appropriate labels.

Some people may want to make "pinprick" dots, under the belief perhaps that this adds to precision. However, very tiny dots are difficult to see. Furthermore, the Standard Celeration Chart has a multiply divide scale, so having a large dot will not detract from precision. Just center it on its day line and frequency line. Then, recognize that the important difference in frequencies is multiplicative. It matters little if a large dot standing for 12 per minute correct also covers up where 11, 10, and 13, and 14 go.

Another exception concerns an important issue regarding "chartjunk." Not all extraneous marks on a chart should be considered as junk. There are cases where it may be best to reprint an actual working chart, rather than "clean it up" to make it presentable. A student's chart may have doodles, comments, and so on drawn onto it. Publishing it "as is" helps preserve the record of what actually happened and may help illustrate how working charts may look. The real world is not always neat and tidy. A working chart containing such junk had that junk on it while it was being used for making decisions. Therefore, publishing one or more working charts as a record of what one actually did also preserves some honesty about monitoring behavior.

Conclusion

Tufte's book presents a number of issues of strategic importance to the display of quantified information. For our purposes it provides some additional arguments that buttress the importance of using standard charts. The book provides useful counter-arguments to the questionable charting practices that exist in behavior analysis and in education. Moreover, it casts these issues in a colorful, visually interesting volume, one that replicates many unusual charts, some of which are of historical importance.

However, the book is not for everyone. Beginning charters and people new to precision teaching may find the issues either too complex or too irrelevant to their needs. Trying to teach them Tufte's arguments and suggestions may add confusion. Advanced charters and established professionals, however, may find greater value in Tufte's book, especially when faced with countering periodic attacks leveled against the Standard Celeration Chart. Or, they may find value when trying to explain some subtle charting issues to colleagues and to fellow professionals.

Tufte's book primarily concerns published charts. It does not concern itself with what we in precision teaching call working charts. Most of what Tufte deals with has to do with charts that will end up in books, journal articles, or in other archival documents. For those purposes it has many valuable considerations. However, for everyday working charts, which teachers and learners use to make decisions, the points made by Tufte will seem largely superfluous – unless such individuals are tempted to go off and create their own charts. There is a certain tendency of people to want to do this, and if they do, then what Tufte says comes into play at that point.

Tufte's book does not explain how to draw charts and graphs. For that purpose a general source such as Robertson (1988) may prove more valuable. Moreover, Tufte's book does not contain a taxonomy of different chart types, nor coverage of the unique properties of each one of the basic types of charts. For such purposes a book such as Schmid's (1954) may have much more use. Finally, Tufte does not address the specific issue of standard charts, and the concept of standard charts appears not to be a consideration. Thus, the rationale for using standard charts, and how to use them, will require other sources, such as Pennypacker, Koenig, & Lindsley's (1972) Handbook of the Standard Behavior Chart. However, bearing these deficits in mind, all in all Tufte's book would make a valuable addition as a resource for established professionals and for those who have a specific interest in measurement and charting issues and topics.

REFERENCES


Journal Description

The Standard Celeration Society publishes the *Journal of Precision Teaching and Celeration* (JPTC) two times a year. JPTC provides a forum for research, practical applications and discussions of Precision Teaching and Celeration technology. JPTC has dedicated itself to the promotion and diffusion of Precision Teaching and Standard Celeration technologies.

Journal Sections:

Authors may submit their original contributions to one of five sections of JPTC:

I. Application Articles: “Application articles” require:
- (1) Use of Standard Celeration Charts;
- (2) Use of basic charting conventions;
(See the JPTC guidelines for guidance on the “basic charting conventions”);
- (3) Description of variables or procedures supporting the interpretation of the data.

“Application articles” usually represent data from applied settings such as schools, clinics, human service agencies.

II. Research Articles: “Research articles” require:
- (1) The use of Standard Celeration Charts;
- (2) Descriptions of the collection and analysis of data;
- (3) Use of basic and advanced charting conventions and analysis;
(See the JPTC guidelines for guidance on the “basic” and “advanced” charting conventions and analysis);
- (4) Description of variables or procedures supporting the interpretation of the data;
- (5) Control for extraneous variables or report of their influence.

III. Discussion Articles: “Discussion articles” offer explanations, reviews, and extensions of Precision Teaching and Standard Celeration concepts.

IV. Chart Shares: “Chart shares” contain data displayed on Standard Celeration Charts along with brief descriptions of the performer, what occurred, and other relevant observations.

[Note: We encourage performers (e.g. students, clients, patients) to submit their own charts to the chart share section.]

V. Technical Notes: Brief technical descriptions clarifying, elaborating, or reporting upon Precision Teaching and Standard Celeration concepts.

Submission Guidelines:

To submit a manuscript authors must conform to the following guidelines:
- (1) Submit three (3) typewritten, doubled spaced copies of the manuscript without author’s names or affiliations;
- (2) Follow the format outlined in the Publication Manual of the American Psychological Association (5th edition, 2001);
- (3) Do not exceed 20 words in the article title;
- (4) Include an abstract and do not exceed 250 words in the abstract;
- (5) Select 3 to 5 key words that describe the manuscript;
- (6) Secure permission for use of copyrighted materials;
- (7) Send submissions to: Dr. Richard M. Kubina Jr., The Pennsylvania State University, Department of Educational and School Psychology and Special Education, 231 CEDAR Building, University Park, PA 16802-3109.

The Editors reserve the right to edit all material accepted for publication.
## BASIC CHARTING CONVENTIONS for the DAILY STANDARD CELERATION CHART

<table>
<thead>
<tr>
<th>TERM</th>
<th>DEFINITION</th>
<th>CONVENTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. CHARTED DAY</td>
<td>A day on which the behavior is recorded and charted.</td>
<td>1. Chart the behavior frequency on the chart on the appropriate day line.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2. Connect charted days except across phase change lines, no chance days and ignored days.</td>
</tr>
<tr>
<td>a) ACCELERATION TARGET FREQUENCY</td>
<td>Responses of the performer intended to accelerate.</td>
<td>Chart a dot (●) on the appropriate day line.</td>
</tr>
<tr>
<td>b) DECELERATION TARGET FREQUENCY</td>
<td>Responses of the performer intended to decelerate.</td>
<td>Chart an (x) on the appropriate day line.</td>
</tr>
<tr>
<td>2. NO CHANCE DAY</td>
<td>A day on which the behavior had no chance to occur.</td>
<td>Skip day on daily chart.</td>
</tr>
<tr>
<td>3. IGNORED DAY</td>
<td>A day on which the behavior could have occurred but no one recorded it.</td>
<td>Skip day on daily chart. (Do not connect data across ignored days.)</td>
</tr>
<tr>
<td>4. COUNTING-TIME BAR (aka Record Floor)</td>
<td>Designates on the chart the performer's lowest possible performance (other than zero) in a counting time. Always designated as &quot;once per counting time.&quot;</td>
<td>Draw solid horizontal line from the Tuesday to Thursday day lines on the chart at the &quot;counting-time bar.&quot;</td>
</tr>
<tr>
<td>5. ZERO PERFORMANCE</td>
<td>No performance recorded during the recording period.</td>
<td>Chart on the line directly below the &quot;counting-time bar.&quot;</td>
</tr>
<tr>
<td>6. PHASE CHANGE LINE</td>
<td>A line drawn in the space between the last charted day of one intervention phase and the first charted day of a new intervention phase.</td>
<td>Draw a vertical line between the intervention phases. Draw the line from the top of the data to the &quot;counting-time bar.&quot;</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Words, symbols or phrases written on the chart in the appropriate phase to indicate changes during that phase.</td>
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</tr>
<tr>
<td>7.</td>
<td><strong>CHANGE INDICATOR</strong></td>
<td>Write word, symbol and/or phrase. An arrow (&gt;) may be used to indicate the continuance of a change into a new phase.</td>
</tr>
<tr>
<td>8.</td>
<td><strong>AIM STAR</strong></td>
<td>A symbol used to represent: (a) the desired frequency, and (b) the desired date to achieve the frequency.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Place the point of the caret: ^ for acceleration data ( \downarrow ) for deceleration data on the desired aim date. Place the horizontal bar - on the desired frequency. The caret and horizontal line will create a &quot;star.&quot;</td>
</tr>
<tr>
<td>9.</td>
<td><strong>CALENDAR SYNCHRONIZE</strong></td>
<td>A standard time for starting all charts.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>It requires three charts to cover a full year. The Sunday before Labor Day begins the first week of the first chart. The twenty-first week after labor day begins the second chart. The forty-first week after Labor day begins the third chart.</td>
</tr>
<tr>
<td>10.</td>
<td><strong>CELERATION LINE</strong></td>
<td>A straight line drawn through 7-9 or more charted days. This line indicates the amount of improvement that has taken place in a given period of time. A new line is drawn for each phase for both acceleration and deceleration targets. (Note: For non-research projects it is acceptable to draw free-hand celeration lines.)</td>
</tr>
</tbody>
</table>

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No text extracted from the image.
ADVANCED CHARTING CONVENTIONS for the DAILY STANDARD CELERATION CHART

<table>
<thead>
<tr>
<th>TERM</th>
<th>DEFINITION</th>
<th>CONVENTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>Frequency:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. FREQUENCY CHANGE (FC) (aka frequency jump up or jump down)</td>
<td>The multiply &quot;x&quot; or divide &quot;÷&quot; value that compares the final frequency of one phase to the beginning frequency in the next phase. Compute this by comparing: (1) the frequency where the celeration line crosses the last day of one phase -to- (2) the frequency where the celeration line crosses the first day of the next phase. (e.g. a frequency jump from 6/minute to 18/minute. FC = x 3.0)</td>
<td>Place an &quot;FC =&quot; in the upper left cell of the analysis matrix. Indicate the value with an &quot;x&quot; or &quot;÷&quot; sign (e.g. FC = x 3.0)</td>
</tr>
<tr>
<td>Celeration:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. CELERATION CALCULATION (Quarter-Intersect Method)</td>
<td>The process for graphically determining a celeration line (aka &quot;the line of best fit.&quot;) (1) Divide the frequencies for each phase into four equal quarters (include ignored and no chance days), (2) Locate the median frequency for each half, (3) draw a celeration line connecting the quarter intersect points.</td>
<td>See advanced charting conventions sample chart.</td>
</tr>
<tr>
<td>3. CELERATION FINDER</td>
<td>A piece of mylar with standard celeration lines which can be used to compute celeration line values.</td>
<td>Buy commercially or copy and cut out part of the vertical axis on the Standard Celeration Chart.</td>
</tr>
<tr>
<td>4. PROJECTION LINE</td>
<td>A dashed line extending to the future from the celeration line. The projection offers a forecast that enables the calculation of the celeration change value.</td>
<td>See advanced charting conventions sample chart.</td>
</tr>
<tr>
<td>5. CELERATION CHANGE (CC) (aka celeration turn up or turn down)</td>
<td>The multiply &quot;x&quot; or divide &quot;÷&quot; value that compares the celeration of one phase to the celeration in the next phase (e.g. a celeration turn down from x1.3 to ÷ 1.3. CC = ÷ 1.7)</td>
<td>Place an &quot;CC =&quot; in the upper middle cell of the analysis matrix with the value indicated with a x or ÷ sign. (e.g., CC = +1.7).</td>
</tr>
<tr>
<td>6. CELERATION COLLECTION</td>
<td>A group of three or more celerations for different performers relating to the same behavior over approximately the same time period.</td>
<td>Numerically identify the high, middle and low celeration in the celeration collection and indicate the total number of celerations in the collection.</td>
</tr>
<tr>
<td>---------------------------</td>
<td>-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
<td>--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>7. BOUNCE CHANGE (BC)</td>
<td>The multiply &quot;x&quot; or divide &quot;÷&quot; value that compares the bounce of one phase to the bounce in the next phase. Computed by comparing: (1) the total bounce of one phase -to- (2) the total bounce of the next phase. (e.g., a bounce change from x 5.0 to x 1.4, BC = ÷ 3.6)</td>
<td>Place a &quot;BC=&quot; in the upper right cell of of the analysis matrix with the value indicated with a multiply &quot;x&quot; or divide &quot;÷&quot; symbol (e.g., BC = ÷3.6)</td>
</tr>
<tr>
<td>8. ANALYSIS MATRIX</td>
<td>The analysis matrix provides the numeric change information regarding the effects of the independent variable(s) on frequency, celeration and bounce between two phases.</td>
<td>Place the analysis matrix between the two phases being compared. For acceleration targets place the matrix above the data. For deceleration targets place the matrix below the data.</td>
</tr>
<tr>
<td>Optional:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>9. FREQUENCY CHANGE P-VALUE (FCP)</td>
<td>The frequency change p-value is the probability that the noted change in frequency would have occurred by chance. (Use the Fisher exact probability formula to compute the p-value.)</td>
<td>Use &quot;FCP =&quot; and indicate the p value in the lower left cell on the analysis matrix (e.g., FCP = .0001).</td>
</tr>
<tr>
<td>10. CELERATION CHANGE P-VALUE (CCP)</td>
<td>The celeration change p-value is the probability that the change noted in celeration would have occurred by chance. (Use the Fisher exact probability formula to compute the p-value.)</td>
<td>Use &quot;CCP =&quot; and indicate the p value in the lower middle cell of the matrix (e.g., CCP = .0001).</td>
</tr>
<tr>
<td>11. BOUNCE CHANGE P-VALUE (BCP)</td>
<td>The bounce change p-value is the probability that the change noted in bounce would have occurred by chance. (Use the Fisher exact probability formula to compute the p-value.)</td>
<td>Use &quot;BCP =&quot; and indicate the p value in the lower right cell of the analysis matrix (e.g., BCP = .0001).</td>
</tr>
</tbody>
</table>
ERRATUM

On the front cover the names listed for the article “Curriculumb-Based Measurement Reading Scores as Dynamic Indicators of Basic Reading Skills” follow: Michael D. Hixson and Margaret T. McGlinchry. As spelled in the article on page 10, Margaret’s last name should read “McGlinchey.”

On page 40, the "Advanced Charting Conventions" text does not have a "Bounce Change" description. The description appears in this Volume. Additionally, minor changes will appear to definitions over time and those minor revisions will not appear in the "Erratum" section.
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Mail form and payment to:  Standard Celeration Society Treasurer Brad Frieswick
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For additional information:  814-863-2400 (voice)  •  SCStreas@aol.com  •  rmk11@psu.edu (email)

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Open an account and choose the Send Money option.
Send money to SCStreas@aol.com

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55 Erratum

A Publication of
The Standard Celeration Society
STATEMENT OF PURPOSE: As the official journal of the Standard Celeration Society, the Journal of Precision Teaching and Celeration has dedicated itself to a science of human behavior founded on a technology of direct, continuous, and standard measurement. This measurement technology includes: a standard unit of behavior measurement – frequency; a standard measure of change in behavior frequencies – celeration; a standard measure of the variability of behavior frequencies – bounce; and a Standard Celeration Chart to display frequency, celeration, and bounce data. The Standard Celeration Chart enables chart-based statistical procedures to determine changes in frequency – frequency jumps, changes in celeration – celeration turns and changes in bounce – bounce verge.
EDITORIAL

Since becoming the editor of the Journal of Precision Teaching and Celeration in 2002, I have had the opportunity review all types of Precision Teaching research. True to the definition of Precision Teaching, an approach that systematically measures instruction and facilitates decision making, Precision Teaching continues to evolve. The current issue has a number of articles that highlight how Precision Teaching stays true to its form but adapts to the changing needs of the current educational system.

Through the application of an intervention method called repeated reading, Sweeney, Ring, Malanga and Lambert show celeration and learning pictures of elementary aged students who improved their reading. Berens, Boyce, Berens, Doney and Kenzer show how Precision Teaching can evaluate retention, endurance and application, three critical learning outcomes associated with fluency. The two articles both demonstrate that Precision Teaching’s strong measurement system allows a view of behavior not otherwise available. Additionally, the articles show how the orderly application of Precision Teaching over many years has resulted in a technology of learning born of thousands of standard celeration charted data.

A tradition that has its roots in a respect for standard displays of behavior, chart shares have continued to appear in the Journal of Precision Teaching and Celeration as well as at conferences and informal gatherings. The charts in this issue show the diversity of those that use Precision Teaching. Anderson and Alber share a chart showing how a 15-year old student learned to read better and changed his behavior when it came time for his reading instruction. King, Moors, and Fabrizio share a chart that displays a child with autism learning difficult prepositions. Fabrizio, Schirmer, Vu, Diakite and Yao present standard celeration charted data detailing how two variables affect the joint attention of a child with autism. And last, Stevens chart share examines efficient ways of monitoring a learner’s progress.

Richard M. Kubina Jr.
Editor, The Journal of Precision Teaching and Celeration
Using Curriculum-Based Assessment and Repeated Practice Instructional Procedures Combined with Daily Goal Setting to Improve Elementary Students Oral Reading Fluency: A Preservice Teacher Training Approach*

William J. Sweeney, Mary M. Ring, Paul Malanga
The University of South Dakota

Michael Charles Lambert
Cleveland State University

This demonstration project evaluates the effectiveness of repeated reading techniques combined with daily goal setting to build oral reading fluency with fourth-grade students. This reading fluency demonstration project was a combined effort of the School of Education at The University of South Dakota with the teachers in the Sioux City Community Schools. This project was designed to address some of the reading needs of students enrolled in one of its elementary schools with a large population of academically at-risk students. Thirty-nine fourth-grade students, from two general education classes, worked with 8 undergraduate practicum tutors from the university. The practicum tutors worked with the students in groups of 1 to 4 for approximately 45 minutes focusing on basic reading skills. The tutors met with their groups two to three days a week on average for approximately five weeks. The experimental design used was an analysis of fluency celerations and learning pictures common to Precision Teaching programs. Precision Teaching measurement procedures were employed to evaluate the repeated readings procedures. Results showed substantial fluency improvements with multiplying learning pictures for oral reading passages. The implementation of these procedures were effective at improving the students’ reading fluency, were cost effective in terms of time and resources, and took little time to administer. Implications for classroom instruction and adoption of repeated reading procedures for both students academically at-risk and teacher training are discussed.

DESCRIPTORS: Precision Teaching, reading fluency, repeated reading

Many authorities point out the importance of structured, repeated practice for students to assure proficiency with any skill taught in the classroom (Samuels, 2002). High performance athletes, musicians, artisans, and accomplished writers all understand the importance of prolonged, structured, daily practice routines to assure mastery of the skills required in their profession. In fact, a concert violinist or an accomplished baseball pitcher would not think of playing a formal concert or pitching in a competitive baseball game without ensuring that they engaged in sufficient daily practice to ensure mastery of their instrument or of their fastball. In fact, many adults fondly, and sometimes not so fondly, reminisce about the hours they spent as a youth practicing their flute, drawing sketches of a tree, or practicing their wrist shots in hockey. Most of these adults will also readily acknowledge the importance of these practice opportunities to their ability to excel in a recital, concert, formal art exhibit, or a competitive athletic activity (i.e., game, meet, or race). Unfortunately, as Samuels (2002) points out in relation to fluency development: "Although there is universal recognition that fluency (i.e., practice) is important, too little is done in the classroom to develop this important skill level" (p. 166).

The National Reading Panel (NRP) reaffirmed the importance of practice and fluency building procedures in its final seminal report, Teaching Children to Read (2002). The NRP report not only discussed the importance of daily practice in learning to read the alphabetic and phonemic code as well as building fluency in reading textual material, but it also addressed the need for fluency building procedures based on research

*Special thanks is extended to Mr. Doug Robbins, Principal, and Jenny Wetz and Laurie Powell, Fourth-Grade Teachers, at Smith Elementary School in the Sioux City Community Schools for their support, hospitality, and willingness to allow us to work within their school’s on this project.

*Requests for reprints should be addressed to William J. Sweeney, Ph.D., The University of South Dakota, Division of Curriculum & Instruction, Special Education Program, 414 E. Clark Street, Vermillion, SD 57069.
findings for adequate understand and comprehension of the reading text. Further, the NRP report emphasized the need for regular assessment of reading fluency in the classroom to assure that students are making adequate progress and to assure that if reading problems are exhibited that "timely and effective instructional response" or remediation is implemented to ameliorate said difficulties (p. 7). Even though reading fluency procedures are largely overlooked during regular reading instruction according to Reutzel and Hollingsworth (1993), they are an essential component of good reading instruction. Good reading instruction assures that students not only correctly identify the words within the text but are able to do this decoding automatically, therefore, allowing the student to divert their attention to the meaning of the text rather than concentrating on the sounding out of individual words. Thus, the introduction of fluency building procedures into reading instruction is an essential aspect for good teaching in this area as well as a necessity for improving the reading performance of students in the classroom.

Samuels (1979) advocated for the incorporation of reading fluency (i.e., speed and accuracy) procedures during reading instruction. Unfortunately, as was pointed out earlier, reading quickly and accurately are often overlooked outcomes of good reading instruction. Authorities say that (a) oral fluency is a necessary feature of good reading, (b) readers can acquire fluency with instruction, and (c) fluent reading improves overall reading ability (Howell & Lorson-Howell, 1990; Sweeney, Omness, Janusz, & Cooper, 1992; Teigen, Malanga, & Sweeney, 2001). Fluency is a means for quickly and easily mastering new skills (Lindsley, 1992; Kameenui, Simmons, Baker, Chard, Dickson, Gunn, Smith, Sprick, & Lin, 1998; Sweeney, 1992; Sweeney, Sweeney, & Malanga, 2001). Fluent readers become experts because they are more proficient at incorporating complex skills, assimilating large amounts of content, understanding knowledge structures, and problem representation (Sweeney, 1992; Mastropieri, Leinart, & Scruggs, 1999). In addition, fluency is related to the eventual generalization and maintenance of reading skills (Levy, Nichols, & Kohen, 1993; Max & Caruso, 1998; Sweeney et al., 1992; Teigen et al., 2001).

The purpose of repeated readings is to build fluency (Samuels, 1979; Rashotte & Torgesen, 1985). Three components have been emphasized in research on oral reading fluency: (a) decoding, (b) overall reading speed and accuracy, (c) and the relationship between reading fluency and comprehension. Research documents the effectiveness of reciprocal peer tutoring and a Precision Teaching measurement system with repeated readings to improve the reading fluency of elementary and severe behavior handicapped learners (Dowhower, 1989; Downs & Morin, 1990; Daly & Guldswog, 1992; Lee, 1990; Sweeney, 1992; Sweeney et al., 1992; Teigen et al., 2001). Additional research on potential classroom applications of repeated readings reaffirm the robust nature of this procedure and encourage more frequent use of this instructional method (Bolich & Sweeney, 1996; Durgunoglu, Mir, & Arino-Marti, 1993; Homan, Klesuis, & Hite, 1993; Sweeney et al, 1992).

For example, Teigen et al. (2001) implemented a combined repeated readings procedure with an error correction package to improve the reading performance of a 10-year-old boy who was participating in a summer reading clinic. The combination of the repeated readings and the error correction procedures was successful at increasing the number of words read correctly while simultaneously decreasing the words read incorrectly across a 10 day instructional period. Additionally, Sweeney et al. (1992) showed that repeated readings combined with Precision Teaching measurement approaches were responsible for the reading improvements of a 43-year-old male who was diagnosed as functionally illiterate. Not only did the repeated readings improve his ability to read and understand textual material, but the reading instruction was also responsible for his reported improvement in self-confidence as it related to reading tasks. Further, repeated readings were successfully implemented on a classwide basis with third- and fourth-grade students while working with undergraduate tutors from a local university (Robbins, Sweeney, Ring, & Sweeney, 1999).

Although the focus of this project was to improve the reading performance of the students with mild disabilities who were in an inclusive setting, the results indicated improvements in oral reading fluency all of the students in the classroom. The importance of this study was that repeated readings and fluency building procedures are effective for improving reading performance regardless of whether a student is experiencing reading difficulties or are already reading at appropriate levels. Thus, teachers who incorporate repeated reading procedures and fluency building strategies as a component of their reading instruction are going to improve the reading skills of students who are exhibiting reading difficulties, while enhancing the reading performance of those students who are achieving adequately in the classroom. One of the important difficulties in the integration of repeated reading procedures is the need to ensure effectiveness of the fluency building strate-
gy. Integrating Precision Teaching measurement systems with repeated readings instruction as a method to build reading fluency is frequently advocated by authorities in the area of curriculum-based measurement (Binder, 1990) and curriculum-based assessment (Sweeney, Ring, Robbins, Larsen, & Schnetzer, 1998). Precision Teaching measurement provides a frequency of responses over time and across days as its measurement unit. For example, a teacher can count the number of words read correctly or incorrectly and divide that number by the time allocated for assessment (e.g., one-minute) and come up with a count per minute measure. This count per minute measure is then charted on the Standard Celeration Chart across a series of days, thus providing the teacher with a quantifiable visual analysis mechanism that is sensitive to daily changes in reading performance. The teacher then possesses the information necessary to determine the effectiveness of the strategies, curriculum, and time required to improve a student's reading performance. Likewise, if the data from the chart indicates deteriorating or stagnant performance, the teacher possesses the immediate feedback from the student's performance that suggest that changes, modifications, or accommodations in the instruction are required. Precision Teaching measurement approaches provide the teacher with a powerful tool for assessing student's reading performance as well as providing a feedback mechanism to ensure the effectiveness and appropriateness of the instruction.

Research shows that the immediacy and frequency of teacher delivered feedback, such as that provided by Precision Teaching measurement approaches, is functionally related to improvements in students' academic achievement (Cooper, Heron, & Heward, 1990; Van Houten, 1980). Public posting systems are one measurably effective means that are recommended to assist teachers in providing students with effective and meaningful feedback on their classroom reading performance (Lambert, Sweeney, & McLaughlin, 1996). An important component of many public posting systems is academic goal setting or setting instructional aims. Unfortunately, few studies or projects have appeared in the literature over the past 10 years documenting the effectiveness of daily goal setting for the improvement of reading fluency skills in the classroom.

Cooper, Kubina, and Malanga (1998) provided a set of guidelines for chart collections or frequency collections by teachers as a means of displaying individual student performance on the Standard Celeration Chart for the purposes of summative evaluation. Although integrating repeated readings and daily goal setting combined with Precision Teaching measurement approaches was shown as an effective means of improving student's oral reading fluency (Robbins et al., 1999), few recent articles in the literature display classwide summaries of improvements in reading fluency. Even though the monitoring of individual reading performance is at the heart of Precision Teaching, an important gap appears to exist in relationship to displaying a visual summary analysis of classwide improvements in reading fluency performance.

**Purpose.** This demonstration project evaluated the effectiveness of repeated reading techniques on oral reading fluency for students academically at-risk on a classwide basis. A concurrent goal of this demonstration was to document the importance and effectiveness of integrating procedures for daily goal setting, as part of an overall treatment package, for assisting students at improving their reading skills. Finally, this demonstration project shows the efficacy of using chart collections as a means of summative, classwide evaluation of the reading fluency instruction.

**METHOD**

**Participants.** Thirty-nine fourth-grade students, from two general education classes, worked with 8 practicum tutors from the university. The practicum tutors worked with the students in groups of 1 to 4 for approximately 45 minutes focusing on basic reading skills. Over half of the students from both of these classes had been identified with reading problems and were enrolled in classes for students in special education, English as a Second Language, or Title 1 reading. Further, the classroom teachers identified several students that were not currently enrolled in these remedial programs who were at-risk for academic problems due to social behavior, attendance, or other behavioral concerns.

**Setting.** This demonstration project took place at Smith Elementary School in Sioux City, Iowa during the spring of 2002. The school that participated in this project is located in a racially and ethnically diverse section of the community. Roughly 61% of the students come from minority backgrounds (i.e., Hispanic, Native American, African American, Vietnamese, etc.) with an unusually high percentage enrolled in English as Second Language programs. Based upon the school district's measure of socio-economic status (i.e., free or reduced school lunch programs), close to 68% of the students could be considered from economically deprived backgrounds (i.e., below what could be considered the poverty line).

Two integrated classrooms of students took
part in a combined repeated readings and goal setting instructional intervention. The repeated readings were conducted in the students' respective classrooms or in the hallway adjacent to the classrooms. Tutors utilized the hallway because of limited space for the small groups and to eliminate as many auditory distractions as possible. Students from these classes worked in groups of 1 to 4 students with trained undergraduate special education practicum tutors. A university supervisor and the classroom teachers served as mentors/coaches for the practicum tutors. These tutors used a combined repeated reading procedure with daily goal setting as well as Precision Teaching evaluation approaches to document the students' progress at building oral reading fluency. The practicum tutors sat across or perpendicular to the students in their respective tutoring groups.

**Movement Cycle/Movement Procedure.** The movement cycle for oral reading was the number of words orally read during an one-minute timing. The learning channels for oral reading were see/say (see word/say word). The corrects were the number of words read correctly during the one-minute timing. The incorrects were the number of words read incorrectly (i.e., omissions, substitutions, additions, and mispronunciations) during the same period.

The practicum tutor provided a retelling procedure for the student following oral reading timings. The retelling consisted of a free recall for the student in which they would tell all the information and details that they could remember from the reading passage. During the oral retell, the tutors counted key points related to the characters, facts, and specific action verbs from the passage. Although the oral retells were counted, recorded, and charted, they are presented in this article due to space limitations.

**PROCEDURE**

**General Procedures.** Prior to the beginning of the instruction, the classroom teacher filled out a brief survey on each student providing an approximation of the students' overall reading level, vocabulary and sight word recognition level, decoding problems, and any other information necessary to help the practicum tutor get started with instruction. Based upon this information the practicum tutor selected three reading passages of approximately 150 to 220 words in length (one passage below the reported reading level, one passage at the reported reading level, and one passage slightly above the reported reading level). These three passages were used during the initial assessment to determine the most appropriate passage for instruction using the repeated reading procedure. Additional curriculum-based measures were taken during the initial tutoring session to get a better understanding of each student's sight word recognition skills, decoding skills, and response patterns, and structural analysis skills.

After the initial assessment, the practicum tutor selected the passage he or she believed would challenge the student but could also be used to improve their oral reading fluency. Instruction consisted of a variety of different decoding, sight word recognition, and reading exercises (e.g., paired readings, neurological impress, chained reading, and specific error correction), which culminated with a one-minute timing for oral fluency on the selected passages. After the repeated readings timing, the practicum tutor conducted an one-minute retelling comprehension probe.

**Goal Setting.** The practicum tutor selected the most appropriate passage (i.e., approximately 150 to 220 words) from the initial oral reading fluency assessment. Prior to the timing, the tutor asked the student what his previous best score was and then asked the student what his goal was for today's reading fluency timing. The practicum tutor prompted and cued the students during the goal setting to ensure that they were selecting a reasonable goal for their repeated readings one-minute timing. A minimum improvement goal from the last session of at least one more word per minute was used during the goal setting procedures. Maximum improvement goals were based upon the tutor's judgment of what was a reasonable goal for the students' to attain, thus ensuring continued intermittent success towards the ultimate fluency aim range of between 180 to 210 correctly read words orally per minute. At the conclusion of the repeated readings, the practicum tutor and the student(s) reviewed, recorded, and charted their best repeated readings score from the day. The tutors celebrated the student(s) accomplishments by rewarding them with stickers or other tokens when they met or exceeded their daily reading goals. The chart and daily goal setting provided an important source of feedback related to the student(s) success in meeting their ultimate instructional aim of reading 180 to 210 words per minute on a selected reading passage (Liberty, 1972; Liberty, 1975; McGreevey, 1983; White & Liberty, 1976).

**Repeated Readings.** The practicum tutors began the fluency training by reviewing the passage with the student prior to implementing the one-minute repeated readings time trial. During this review, the tutor corrected any errors and provided additional instruction on portions of the passage that appeared especially difficult for the
student to master. When the tutor believed that the student reviewed the passage sufficiently and was ready for the one-minute timings, she or he cued the student to get ready for their repeated reading timing. The tutor set his/her digital countdown watch (or kitchen timer) for one minute. Then the tutor provided a specific cue, such as "Ready? Five seconds, Go!" to let the student know when to start reading. While the student read out loud, the instructor followed the passage on his own sheet marking any errors that needed to be corrected following the one-minute timing. Previously, the tutor told the student to read out loud as fast as he could and if he did not know a word to skip it and go on to the next word. When the beep of the watch sounded the student stopped reading. Following the conclusion of the one-minute timing, the practicum tutor recorded the data and corrected any errors, and the student determined if he/she met the goal. Often during the daily goal setting analysis, the student requested another repeated readings timing to try and better his or her current daily score. Additional timings were encouraged when time permitted, and the student's best score for the day was counted, recorded, and charted. Finally, during the daily goal setting portion of the instruction, the practicum tutor rewarded the student for meeting the intermittent reading goal and helped the student to select new goals for the next instructional session.

RESULTS

Data from the students' summary charts collections (see Charts 1-6) showed substantial improvements in all of the students' oral reading fluency performance through the use of repeated readings and goal setting procedures across multiple reading passages. The upward celerations that related to the increasing number of correctly read words were indicative of climb learning pictures for the students. Also, many of the student(s) oral reading performance more than doubled per week, multiplying generally at a X2.0 or greater. Some of the students exhibited periodic celerations, multiplying at X10.0 or more per week. Data also indicated that the error correction procedures were successful for most of the students. Error responses for most students after the initial sessions remained below 5 per minute or less for most students. Additionally, the overall performance change for most students multiplied by X3.0 to X6.0 in most cases. Finally, many of the students met or exceeded the terminal instructional aim of 180 to 210 words per minute, correcting data or celerations below the record floor for the development of oral reading fluency (Biemiller, 1977; Dowhower, 1987; O'Shea, Sendeckyj & O'Shea, 1985; Robbins et al., 1999; Sweeney, 1992; Sweeney et al., 1992). Although it can not be said that daily goal setting was solely responsible for the improvements of these students' oral reading fluency, it can be said that the daily goal setting was an important component of the treatment package which was responsible for these reading improvements. Comments made by the elementary students and the affective enthusiasm showed by these students about both their tutors and the successful performance that they exhibited further exemplify the importance of this project for the students who participated. In fact, these same elementary students asked the first author, months after the completion of the project, when the university tutors were returning to work with them. From a teacher training perspective, this demonstration project provided an excellent opportunity for undergraduate practicum tutors to gain valuable instructional and curriculum-based assessment opportunities in a structured, highly supervised, real world setting. The relatively simple to follow instructional strategies and the straight forward Precision Teaching evaluation system provided the undergraduate tutors the basic instructional foundations for success when working with students with disabilities or who were academically at-risk. In fact, comments made from graduating students teachers, who had completed a similar experience two to three years before, reported that the tutoring practicum was largely responsible for their understanding and
integration of specific curriculum, instructional materials, and strategies as they progressed through their teacher preparation program. In short, the opportunity to employ these procedures with real students in a supervised setting assisted these practicum tutors to gain a greater mastery and fluency of important instructional teaching behaviors.

Several important limitations need to be considered when evaluating the results of this study. First, the demonstration project met on average twice a week for only 5 weeks. Had the practicum tutors been able to continue the intensive tutoring for a longer period of time, such as a year, it is probable that much more substantial results may have been obtained. Secondly, the tutors worked in small groups of 2 to 3 students. Working intensively, with highly trained tutors, in small groups is often not practical or feasible for most general education teachers. Additional training and support may enable these teachers to develop peer tutoring or cooperative grouping strategies that could adopt or modify these fluency building and daily goal setting strategies in the regular classroom (Maheady, Michielli-Pendl, Mallette, & Harper, 2002; Smith, Tyler, Easterling, Smith-Davis, Clarke, & Mims, 2002). Unfortunately, training in developing peer tutoring or cooperative grouping strategies are too often only the auspices of those in special education and are not contained or satisfactorily taught in general education teacher training programs (Greenwood & Maheady, 1997). Further, by utilizing summary chart collections as a potential decision making tool, practitioners run the risk of masking or inadvertently missing the fine grained nuances of individual daily performance by students related to improvements or potential deterioration of oral reading fluency. If summary chart collections are employed as the sole decision making tool by teachers and other educational leaders, without an additional analysis of the individual student’s performance, they must interpret these results with caution due to the same threat posed by statistical analysis, i.e., masking the true variability across time of the individual student’s performance (Johnston & Pennypacker, 1993).

Educational practitioners need to combine the analysis of both the summary chart collections with a thorough analysis of individual student's
charts to avoid making erroneous conclusion related to the effective reading fluency instruction on student's actual reading performance. Finally, further research needs to be conducted related to long term gains of reading fluency instruction, generalization of fluency skills into other curriculum areas, and ways to increase adoption and implementation of fluency building and goal setting procedures by more classroom teachers.

Repeated readings and oral reading fluency procedures hold great promise for improving the overall reading performance of many students. Through the adoption of repeated reading and fluency building approaches, teachers are providing students with the tools so that they can automatically recognize and decode words within the text. When students are able to automatically decode words with in a text, they are provided with a greater opportunity to focus more of their time, attention, and effort in developing adequate reading comprehension skills (Allington, 1977; LaBerge & Samuels, 1974). Although the outcomes of this project for building reading fluency with elementary students are very promising, additional planning and resources are necessary for implementation on a classwide or school wide basis. Through effective collaboration between the local public schools and universities, the opportunity to increase available resources for instructional purposes may be realized. Further, the actual in school teaching experience in a structured and supervised setting provides invaluable experience for preservice teachers and optimizes feedback and resources related to effective instructional practices provided by teacher training programs.

REFERENCES


Since the 1970’s, proponents of Precision Teaching have cited the relation between fluent performance and various long-term academic performance outcomes. Unfortunately, clinical work has mainly used to demonstrate the importance of high correct response frequencies in education. The current paper describes a technology currently being used in a university-based Precision Teaching center to systematically evaluate relations between response frequency and academic performance outcomes with school children. Specifically, three studies are reported which evaluate retention, endurance, and application as a function of response rate during training. Results indicate that higher rates of responding during training yield better performance during tests of retention, endurance, and application. The studies are discussed in terms of technological innovations for educational reform and directions for future research.

DESCRIPTORS: Precision Teaching, fluency, retention, endurance, application

In the Precision Teaching (PT) literature, Retention Endurance Application Performance Standards (REAPS) have been described as the positive outcomes to fluent performance. From this perspective, fluency is defined as a mastery criterion that requires both accuracy and speed (i.e., high correct response frequencies). Proponents of fluency-based instruction suggest that fluent performers are more likely to maintain their accurate, high-rate performances over periods of time without practice (retention) and over long durations in the presence of distractions (endurance/stability), as well as acquire complex skills more quickly and easily (application/adduction) (Binder, 1996; Bloom, 1986; Johnson & Layng, 1992; Lindsley, 1971).

As described above, REAPS could have great significance for learners in traditional education settings. First, increased skill retention following extended school absences (e.g., summer break) would require that less time be spent reviewing skill objectives from the previous school year. Second, behavioral endurance during standardized tests could enhance student performance by decreasing distractibility and fatigue. Finally, application outcomes could increase the likelihood that learners would continue to excel in and pursue advanced coursework during their secondary or post-secondary educations. Overall, it appears that if fluency leads to REAPS, fluency-building strategies may be used to complement more traditional methods of instruction as a means of producing better learning gains.

The notion of fluency extends beyond the PT literature. Proponents of curriculum-based measurement (CBM) also use behavior frequency as a basic unit of measurement for evaluating academic proficiency (Deno, 1985; Fuchs, Deno, & Mirkin, 1984; Marston, Mirkin, & Deno, 1984). CBM maintains similarities to PT in that count per time per time, or responses per minute per week, serves as the basic datum from which educational decisions are made. Additionally, from both perspectives, the higher the response frequency the more proficient the learner is considered to be. Research in CBM indicates frequency of correct response is as reliable a measure of academic proficiency as commercially available standardized test scores, and tends to provide educators with more information regarding the specific nature of skill deficits (Elliot & Fuchs, 1997; Fuchs & Deno, 1997).

The authors would like to thank Adel C. Najdowski for her contributions to the initial data analyses, which eventually gave rise to this line of research. We would also like to graciously thank Rebecca Flores for her valuable assistance in data collection and implementation of the research protocols. Additional thanks are extended to all of the CAL Tutors and Case Managers, who help make the scientist-practitioner model of clinical practice a reality for our center.

*Correspondence concerning this article should be addressed to Kimberly Nix Berens, Department of Psychology/296, University of Nevada-Reno, Reno, NV 89557 or Thomas E. Boyce, Department of Psychology/296, University of Nevada-Reno, Reno, NV 89557. Electronic mail may be sent to Kimbo88@aol.com or teboyce@unr.edu
A Technology for Evaluating Relations between Response Frequency and Academic Performance Outcomes*

Kimberly Nix Berens, Thomas E. Boyce, Nicholas M. Berens, Janice K. Doney, and Amy L. Kenzer

University of Nevada-Reno

Since the 1970's, proponents of Precision Teaching have cited the relation between fluent performance and various long-term academic performance outcomes. Unfortunately, clinical work has mainly been used to demonstrate the importance of high correct response frequencies in education. The current paper describes a technology currently being used in a university-based Precision Teaching center to systematically evaluate relations between response frequency and academic performance outcomes with school children. Specifically, three studies are reported which evaluate retention, endurance, and application as a function of response rate during training. Results indicate that higher rates of responding during training yielded better performance during tests of retention, endurance, and application. The studies are discussed in terms of technological innovations for educational reform and directions for future research.

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Although there are differences between how PT and CBM use fluency as a measure of learning, it is generally agreed upon that fluent performances result in long-term benefits to the learner. Unfortunately, much of the evidence for REAPS has been obtained clinically (Binder, 1996). Although clinical evidence is important and should not be overlooked, it appears that more rigorous empirical work evaluating the relation between increasing response frequencies and REAPS is sorely needed. In order to influence a shift in traditional educational practices in favor of behavior analytic approaches that emphasize frequent measurement and true skill mastery, outcome data across large numbers of learners is needed.

The current paper describes a technology currently being used to examine relations between response frequency and REAPS within a university-based PT center. The primary mission of the center is to design effective instructional strategies for improving the academic performances of students in grades K-12. The center is also committed to the use of a scientist-practitioner model of psychological practice where data are systematically collected for use in: (a) making educational decisions, (b) conducting general program evaluation, and (c) disseminating scientific information regarding relations between response frequency and academic performance outcomes.

**GENERAL CENTER OVERVIEW**

**Students**

Twenty-five students in grades one through 10 currently attend the Center for Advanced Learning (CAL) for 2 to 6 hours per week and receive tutoring in mathematics and reading. Each student's curriculum is tailored to meet his/her specific needs and is established from performance on a comprehensive basic skills assessment. Each skills assessment is curriculum-based, such that tests are generated from local grade-level curriculum. However, these curricula are broken down into basic components so that only finite skills are being assessed. Learners' correct responses per minute are initially evaluated for grade-level curriculum. However, if a learner's correct responding falls below the established fluency aims for any grade-level skills, their performances on skills from previous grade levels are evaluated until fluent performances are obtained. Skills at the next level are then targeted for fluency training.

**Curricula**

Similar to the basic skills assessment, the CAL math and reading curricula are composed of various programs that represent overall skill objectives for grades one through 12. These programs are broken down into the basic component skills required for performance of the overall skill objective, or composite skill. For example, the phonetic reading program is broken down into (a) identifying letters, (b) identifying phonics sounds, (c) identifying vowel blends, (d) identifying consonant blends, (e) identifying three-letter words, and (f) identifying words for grade levels 1-12 (all words can be identified through word-attack skills). The stimuli associated with a particular level in a program are presented on various worksheets or sets of flashcards. This levels system applies for all math and reading programs included in the curriculum, with various worksheets and flashcards associated with each level.

A session book is generated for each student. The book includes: (a) a curriculum checklist identifying the component skills and overall composite skill objectives to be mastered during the student's tutoring sessions, (b) paper copies of each skill level in a program to be conducted during tutoring sessions, (c) standard celeration charts (Pennypacker, Koenig, & Lindsley, 1972) for recording correct and incorrect response frequencies obtained during each program, and (d) a log for communicating program changes, directing questions to the Case Managers/Advisors, and describing problems or highlighting achievements that occur during a student's session. Additionally, during fluency training sessions, tutors are equipped with: (a) digital timers for the accurate monitoring of various timing periods, (b) handheld counters for tallying rapid response frequencies, (c) pencils, erasers, and rulers for charting, and (d) boxes of highly preferred stimuli for use as rewards.

**GENERAL TRAINING PROCEDURES**

**Fluency Training**

**Skill introduction.** Skill introduction is the first step in fluency training. Specifically, each student's correct response frequency on an academic task is evaluated during 15-s, 30-s, and 1-min timings. The timing length that produces response frequencies closest to the fluency range determines the interval used for initial training.
For example, if a student engages in higher frequencies on a task during a 15-s timing versus a 30-s or 1-min timing, then frequency building during 15-s timings is introduced. Thirty-second timings are introduced after fluent responding is achieved at 15-s and so on until the learner is performing fluently during 1-min timings.

**Frequency building.** Following skill introduction, frequency building during the previously selected timing length commences. During frequency building, each student is instructed to perform the skill as quickly as possible. Students are periodically prompted during the timing to respond more rapidly (e.g., "Go faster" or "Hurry"), if pausing or decrements in frequency are observed during the interval.

Tutors deliver verbal praise during the course of a timing when a student makes significant improvements in accuracy or frequency as compared to his/her previous timing (e.g., "Awesome" or "Great"). Errors are noted, but corrective feedback is withheld until the end of the timing. At that time, the tutor initiates correction trials for all incorrect items.

A correction trial consists of the tutor instructing the student to respond to the incorrect item again, providing immediate praise for a correct response or immediate corrective feedback for an additional incorrect response. Corrective feedback entails the tutor providing the student with the correct response (i.e., modeling), and then requiring that the student repeat the correct response. The tutor then requires that the student respond to the item again, and provides immediate praise for the correct response. Correction trials of this sort are repeated until the student can emit independent correct responses to all incorrect items.

Throughout the course of the training session, students are eligible to receive verbal, tangible, or edible rewards contingent upon various response requirements. The specific contingency implemented with each student depends upon nuances specific to that individual. For example, some students show rapid increases in response frequencies across days (i.e., high celerations). As a result, these students receive reinforcement for doublings in performance (i.e., X2.0 celeration) throughout the week. However, some students require that reinforcement be made contingent upon accurate responding before increases in frequency can be targeted. Other students require that reinforcement be made contingent upon on-task or compliant behavior.

In addition, it is standard practice in CAL to reinforce a student's performance if fluency is achieved during a given timing length and he/she proceeds to a longer timing length (i.e., increases in endurance). In order for a student to proceed to a longer timing length, his/her response frequency per minute must fall within the fluency range (i.e., divided by .25 and .5 for a 15-s and 30-s timing, respectively). Finally, performance is reinforced for Phase 1 and Phase 2 mastery of a skill.

Phase 1 mastery is achieved when a correct response frequency falls within the fluency range for two consecutive 1-min timings during a session. Phase 2 mastery is achieved when a correct response frequency falls within the fluency range during the first timing conducted on that skill during the first session after Phase 1 mastery has been achieved (generally 2 days apart). If the student fails to achieve Phase 2 mastery, then he/she must restart the mastery sequence (i.e., achieve Phase 1 and Phase 2 mastery on consecutive sessions).

Since individualized programs of instruction are implemented with all students as a means of enhancing learning, the numbers of timings conducted on each skill during each session depend upon individual performance characteristics. Therefore, response opportunities vary across students as a function of their individual performance during sessions, and are evaluated as part of the data analysis in each of studies reported below.

**General Data Collection Procedures and Calculation of IOA**

For all students, frequency of correct responses, incorrect responses, and skipped items are recorded during sessions using standard celeration charts. A standard timings chart is used to record the response frequencies obtained during all timings conducted on a particular skill during a session. After all timings have been conducted on that skill, the highest correct response frequency obtained for that skill area is then plotted on a standard daily chart. Figure 1 shows an actual daily chart from one of our learners, who is also included in the analyses reported below.

Secondary observers obtain point-by-point agreement measures during a portion of all tutoring sessions. At the completion of the analyses reported below, secondary observers had obtained agreement measures for 782 timings conducted throughout the 2001-2002 school year and 2002-summer session. Exact agreement scores were calculated from these measures by first identifying the total number of agreements and disagreements obtained during the timing. Agreements included total number of correct items, incorrect items, and skipped items in which the two observers reported the same score. Disagreements included the num-
ber of correct, incorrect, or skipped items for which conflicting scores were reported. Exact agreement coefficients were then calculated for each timing by dividing the number of agreements by the number of agreements plus disagreements and multiplying by 100%. An overall agreement score across all timings was then calculated. The average agreement score across the 782 timings was 96.87%, and ranged from a low of 78% to a high of 100%.

STUDY 1: RETENTION

Method

Participants

Five students enrolled in CAL were selected for inclusion in the retention analysis. These 5 participants were included due to their having curricula with at least two programs within a similar academic domain having the same fluency aim (65 or more responses/min), thus allowing for appropriate within and between subject comparisons.

Jack (7th grade), Emily (6th grade), Larry (7th grade), and Josie (10th grade) were typically developing students receiving instruction in general education classrooms at private schools in northern Nevada. Jack and Emily were enrolled in CAL to receive skill building in mathematics. Larry and Josie were enrolled to receive skill building in reading and mathematics.

Karen was a 4th grade female with mild Downs Syndrome in special education at a public school in northern Nevada. Karen was enrolled in CAL to receive skill building in reading, mathematics, and fine motor skills. She was also receiving intervention through CAL for disruptive classroom behavior (e.g., out-of-seat behavior, noncompliance, etc.).

Responses

For all participants, correct responses per minute on basic computation flashcards were included in the retention analysis. Basic computation included: (a) addition facts (0-18), (b) subtraction facts (0-18), (c) multiplication facts (0-12), (d) division facts (0-12), (e) reducing fractions, and (f) converting improper fractions to proper fractions. All basic computation flashcard tasks entailed the same fluency aim of 65 or more correct responses per minute. The fluency aim for this skill was established through normative sampling (Binder, 1996), where the number of computation flashcards completed per minute was evaluated across a series of timings conducted with exemplary learners, undergraduate tutors, and graduate students affiliated with our center. The distribution of scores obtained on this skill area across individuals was evaluated to produce a range of optimal frequencies, with 65 facts spoken per minute serving as the low-end of the range.

Reinforcers

All 5 participants received edible rewards (i.e., candy or snacks) for: (a) any increase in response frequency over the previous session, (b) achievement of fluent performance during shortened timing lengths (e.g., 15-s. or 30-s. timings), (c) achievement of Phase 1 mastery, and (d) achievement of Phase 2 mastery. Karen also received edible rewards for staying on-task and following instructions throughout her sessions (these were delivered randomly at the discretion of her tutor).

Retention Probes

Retention probes were conducted on mastered and unmastered skills following a naturally occurring 1-month break between semesters (i.e., winter break). During probes for retention, participants were given up to four opportunities to perform the skill as a means of controlling for warm-up effects. A probe session could involve fewer than four timings if the participant responded fluently for two consecutive timings. For those participants who had achieved Phase 2 mastery of a skill prior to the retention period, failure to perform fluently during two consecutive probe timings resulted in that skill being reintroduced during training.

Data Analysis

Data for the 5 participants were analyzed in terms of median training frequency and total number of responses emitted during training. The relation of these measures to the percentage of retention was explored.

Median training frequency. The median training frequency was calculated from all of the participants’ training data for each separate skill. To calculate the median frequency for a skill, each score obtained on that skill prior to the retention period was entered into a computer database that automatically calculated the median measure for the distribution of values. This median served as a summary measure of the participant’s training performance for use in comparing training performance with the percentage of retention.

Total responses emitted. A total responses emitted score was calculated from each participant’s training data to serve as a measure of practice. This score was calculated for each participant by summing all of the response frequencies obtained across all timings prior to the
retention period. The total responses emitted calculation reflected actual responses. Therefore, the numbers of responses obtained during shortened time periods (i.e., 15-s or 30-s) were not reported as count per minute for this calculation.

Percentage of retention. Percentage of retention was calculated for each participant's performance of a skill during retention probes. To obtain a more comprehensive measure of performance before and during the probe, the percentage of retention calculation involved dividing the average frequency obtained during the retention probe (i.e., summing each frequency obtained during the probe and dividing by the total number included in the sum) by the average of the last two training points obtained before the probe. This computation yielded a percentage of each participant's previous response frequency that was maintained following a period without instruction or practice.

RESULTS

The relation between each participant's median training frequency and the percentage of their previous performance retained during the probe is reflected in the top panel of Figure 2. These data indicate a positive relation between median training frequencies and the proportion of previous performance retained after a 1-month period without practice. In general, it appears that those participants emitting response frequencies closer to the fluency range on particular skills prior to the retention period (Josie, Larry, & Emily), performed better during the retention probes (over 100% retention) than participants responding at lower frequencies on particular skills. In other words, those participants who rapidly progressed towards fluency on a particular skill during practice, and thus achieved a higher overall median training frequencies, appeared to retain more of their performance following the retention period than those who progressed more slowly during training. This relation appears to hold true across participants and, with the exception of Emily, within participants across different basic computation programs.

The relation between each participant's practice opportunities, measured as total responses emitted, and the percentage of their previous performance retained during the probes is reflected in the bottom panel of Figure 2. In contrast to the results obtained for median response frequencies and percentage of retention, these data suggest a negative relation between total responses emitted and percentage of retention across participants. That is, it appears that those participants (Karen and Josie) who engaged in the most cumulative practice (3300 and 4300 responses respectively) on a particular skill retained less of their previous performance. Conversely, those students (Josie and Larry) with the least amount of practice (less than 100 responses) on a particular skill retained as much or more of their performance. This negative relation holds true across participants and, with the exception of Larry and Karen, within participants across the different computation skills. The results for Larry and Karen indicate no relation between amount of practice and skill retention.

DISCUSSION

The current results indicate a positive relation between response frequencies emitted during practice trials and retention of academic performances by school children. It appears that the higher the frequency of correct responding during practice, the greater the amount of previous performance retained following a 1-month period without instruction or practice. The current findings also indicate a somewhat negative relation between amount of practice (i.e., total responses emitted) and retention of previous performance. It appears that additional practice opportunities will not enhance skill retention unless response frequencies are fairly close to the fluency range. Put differently, engaging in additional practice of a skill at low frequencies did not appear to enhance retention following a 1-month period without practice. These findings suggest that response frequencies emitted during practice, rather than simply the overall amount of practice, is a more critical predictor of skill retention.

There are some limitations to the current study. Firstly, retention probes involved assessing performance on basic computation skills following a 1-month absence from instruction or practice. Future research should focus on an examination of additional skill areas and longer retention periods so that the generality of the current findings can be assessed. Additionally, whether students were actually practicing some skills during the retention period is unknown. Therefore, it is difficult to determine the effect that extraneous practice may have had on the current findings.

The current results contradict previous research that has been conducted investigating relations between practice and retention of academic skills. Overlearning, or exposure to varying numbers of practice trials beyond an initial learning criterion, has been shown to produce retention when measured only as accurate responding (i.e., percent correct). In their metaanalysis, Driskell, Willis, and Copper (1992) indicate that larger de-
degrees of overlearning yield greater amounts of retention at various follow-up periods. In other words, learners exposed to more additional practice trials during training tend to perform more accurately after a retention period. Thus, a positive correlation appears to exist between amount of practice and skill retention, when retention is measured as accuracy-only. Our results suggest that this relationship does not hold up when frequency is included in the measure of retention.

**STUDY 2: ENDURANCE**

**Method**

**Participants**

According to the criteria described previously, seven students enrolled in CAL were selected for inclusion in the endurance analysis.

Billy (6th grade), Krissi (4th grade), Joey (2nd grade), and Jim (5th grade) were typically developing students receiving instruction in general education classrooms at public or private schools in northern Nevada. Jack (7th grade), Josie (10th grade), and Karen (4th grade), who were included in the retention analysis, were also included in the endurance analysis.

**Responses**

For all participants, vocally identifying Arabic numerals was included in the endurance analysis. This program requires that students correctly name a series of numbers presented on sheets, with six columns of 16 numbers on each sheet. The numbers presented on each sheet range from the one's to the million's place (depending upon level of difficulty). In other words, the lowest level of the number identification program requires that students name single digit numerals (e.g., 5) and the highest level requires that students name numerals to the millions place (e.g., 1,345,005). Regardless of level, we established the fluency aim for this program according to the recommendation of at least 100 movements (i.e., digits) per minute (Haughton, 1971).

**Reinforcers**

The reinforcement contingencies were the same as those described for the retention analysis, with one exception. In addition to rewards delivered contingent upon training performance, participants also received highly preferred edible rewards for meeting certain performance requirements during endurance probes. These requirements are described in detail below.

Endurance Probes

Endurance probes were conducted following mastery of a skill level. In other words, when a participant achieved Phase 1 and Phase 2 mastery, his/her endurance across a 5-min timing on that skill was evaluated during the next subsequent session. A 5-min timing length was selected for the endurance analysis so that count per min for each minute of the timing could be plotted on a timings chart and within-timing celeration evaluated. Standard charting convention suggests that at least five data points are required for an accurate measure of celeration (Pennypacker et al., 1972). In addition, relative to 1-min training timings, 5-min timings seemed appropriately lengthy for an evaluation of endurance performance.

Prior to conducting an endurance timing, the tutor informed the participant that he/she would be eligible to choose a prize out of the "endurance box" for engaging in responses per minute that fell at or above the fluency aim (total responses/5). The "endurance box" contained candy bars and other treats much larger in size or value than those items typically earned during sessions. Due to the length of the timing requirement, the aim of these rewards was to motivate participants to try their best during the 5-min timing.

The participant was then presented with five different sheets of stimuli (i.e., Arabic numerals from their current level) placed across the table in a row, with one sheet of stimuli associated with each minute of the timing. Once the timing commenced, the tutor followed along while the participant responded, using identical sheets of stimuli for scoring purposes. At the end of each minute, the tutor prompted the participant to "switch" and respond on the sheet of stimuli associated with the next minute. Throughout the timing, the tutor recorded the correct, incorrect, and skipped response frequencies for each minute. At the end of the timing period, the tutor calculated an overall count per minute for the five minutes (total response frequency/5). If the participant's count per minute for the timing was at or above the fluency aim, then the participant was allowed access to the "endurance box."

**Data Analysis**

As in the retention analysis, data for the 7 participants were analyzed in terms of median training frequencies and total number of responses emitted during training. The median training frequency and total number of responses emitted were calculated in the same manner as described in the retention analysis. The relation of these measures to frequency per minute across the 5-min endurance timing was explored. The
frequency per minute for the 5-min endurance timing was calculated by dividing the total number of responses emitted during the entire timing by five.

Results

The relation between each participant’s median training frequency and their frequency per minute during the 5-min endurance probe is reflected in the top panel of Figure 3. These data indicate a positive relation between median training frequencies and frequency of responding during a 5-min endurance probe. In general, it appears that participants emitting response frequencies close to or within the fluency range during training, performed at higher frequencies during the endurance probes. The lowest frequency per minute during the endurance probes was obtained with Karen on a skill where her median training frequency was also below the aim. Josie engaged in the highest median training frequency on a skill and also performed at the highest frequency on that skill during the endurance timing. This relation appears to hold true across participants and, with the exception of Billy and Krissi, within participants across different levels of the numeral identification program.

The relation between each participant’s practice opportunities, measured as total responses emitted, and their frequency per minute during a 5-min endurance probe is reflected on the bottom panel of Figure 3. In contrast to the results obtained for median response frequencies and frequency per minute during endurance probes, these data suggest a negative relation between total responses emitted and endurance frequency when results are analyzed across participants. When results are analyzed within participants across the different skill areas there does not appear to be a relation between these two measures. In other words, as with the results for the retention analysis, it does not appear that practice alone is a good predictor of performance across long timing durations. For example, Krissi performed just as well during the endurance probe on a skill with over 3,000 total responses emitted during training as she did on a skill with less than 1,000 total responses emitted during training. Additionally, Karen showed the best endurance performance on a skill with less than 500 total responses emitted during training.

Discussion

The results for the endurance analysis are similar to those obtained for the retention analysis. It appears that participants were better able to maintain stable, high frequencies of correct responses across long timing durations when their median training performance was within the fluency range. It also appears that practice alone was not a good predictor of endurance. In other words, when frequency is not included in the analysis, amount of practice does not predict how well a student will perform over a long timing duration. Engaging in high frequencies of responding during practice appears to enhance a student’s endurance, or ability to maintain high correct response frequencies over long timing durations.

Some definitions of endurance include resistance to distractions as well as resistance to fatigue. The current study only evaluated resistance to fatigue through an examination of response stability across a timing duration that was five times as long as the typical practice timing duration. Distractions were not included in the current analysis. However, future research should examine the effects of distracters on performance during endurance timings using frequencies of correct responding as a dependent measure. Future research should also examine performance across increasingly long timing durations as a means of evaluating whether there is a point at which endurance breaks down regardless of median training performance. In this way, educators could better understand how to arrange testing or assessment conditions that encourage a learner’s best performance.

STUDY 3: APPLICATION

Method

Participants

Eight students enrolled in CAL were selected as participants for the application analysis. Participants were selected if they had multiple application probes conducted across multiple skill levels within the composite skill objective defined as Identifying Place Value. Mike (4th grade), Daryl (4th grade), Emma (4th grade) and Nathan (3rd grade) were typically developing students receiving instruction in general education classrooms at public or private schools in northern Nevada. Billy, Krissi, Joey, and Jim, who were included in the endurance analysis, were also included in the application analysis.

Responses

For all participants, vocally identifying place value was included in the application analysis. This program requires that students correctly
Figure 3

- Median Training Frequency Across All Practice Timings
- Total Responses Emitted during Training
- Frequency per minute During 5-min Probes

- Billy
- Krissi
- Jack
- Karen
- Joey
- Josie
- Jim
identify the place values for a series of numerals presented on sheets, with six columns of 10 numerals on each sheet. On each sheet, one digit in a numeral is printed in a larger font than the others, indicating to the student that they are to name the place value for that digit (e.g., 5, 263 would require a response of "thousands"). The numerals presented on each sheet range from the one's to the million's place (depending upon level of difficulty). In other words, the lowest level requires that students identify numbers in the ones and tens places. The highest level requires that students identify numbers in the ones through one millions places. Regardless of level, we established the fluency aim of at least 90 movements per minute (i.e., correct place values) according to the recommendations of The Haughton Learning Center, who also provided us with the program.

Reinforcers

The reinforcement contingencies were the same as those described in the retention analysis.

Application Probes

Application probes were conducted at the following training milestones: (a) introduction of a skill level and (b) achievement of fluent performance during the various timing lengths (i.e., 15-s, 30-s, and 1-min timings, respectively). During application probes, participants were required to perform the next level of a skill beyond their current training level during a 1-min timing. For example, if a participant's current training level entailed identifying place values through the ten's place, then his/her application probe level entailed identifying place values through the hundred's place. Therefore, when participants reached one of the milestones described above during their current training level, an application probe was conducted at the next subsequent level. Data were collected during application probe timings in the same manner as during training. However, tutors did not provide feedback on or reinforcement for performance during application probes.

Results

Figure 4 depicts response frequencies across application probes for all participants. In general, it appears that response frequencies during application skill levels increased from the initial probe to the final probe. In other words, as participants achieved fluency at the various milestones on skills targeted during training, their performance on higher-level, untargeted skills also increased. There were a few exceptions to this finding.

Nathan, Billy, and Jim each showed no change or a decrease in response frequency between two probe timings on a skill. However, for these students, probes were not conducted at every milestone and, therefore, a complete data stream was not available. For those participants where probe data were missing for a particular milestone, fluent performance was obtained at shorter timing lengths when the target skill level was introduced. Thus, frequency building initially commenced during longer timing lengths (i.e., 30-s or 1-min), which prevented application probes from being conducted at earlier milestones. Therefore, some of the data streams depicted on the figure appear incomplete.

Figure 5 depicts the relation between Krissi's training performance on targeted skills and her performance during application probes on untargeted skills. The figure indicates that as Krissi's frequencies of responding on targeted skills increased, her frequencies of responding on untargeted skills during application probe timings increased as well. It is also apparent that her time to skill mastery (i.e., fluency) for each subsequent skill level decreased. For example, she required approximately 50 timings to achieve fluency on the first skill level (i.e., 1's-100's), whereas she required only 9 timings to achieve fluency on the fourth level (1's-100,000's). In this way, it appears as though she was able to achieve skill mastery at higher levels more quickly following component skill mastery. This pattern seemed typical when individual performances were analyzed.

Discussion

The current results indicate that increases in response frequencies on targeted skills may lead to increases in frequencies on untargeted skills within the same composite skill objective. In other words, as participants' performances improved on targeted skill levels, corresponding improvements were obtained on higher-level skills prior to the use of specific frequency-building strategies.

These data lend support to the notion of "curriculum leaping," or acquiring upper level skills without direct instruction on those skills (Johnson & Layng, 1992). Given this, requiring more stringent mastery of component skills (i.e., fluency criteria combining accuracy plus speed), might lead to greater overall academic proficiency and critical thinking skills. As many educators have theorized, establishing skills to high frequencies of correct responding might enable those skills to be more readily available for selection by the natural environment. Basic tool skills that occur at high frequencies are more likely to occur on
novel occasions and recombine with other skills to form novel and more complex academic repertoires (Johnson and Layng, 1992).

The current study serves as a stepping-stone for more research in this area. Future research should include analyses of different skill areas across larger numbers of participants as a means of evaluating the generality of the findings. Additionally, unlike the two studies reported previously, practice was not included as a variable in the application analysis. As such, it is difficult to conclude that increases in response frequency on targeted skills were solely responsible for performance improvements on untargeted skills. It may be the case that practice alone improves performance on untargeted skills within the same composite skill objective. Future research examining the role of practice on skill application is needed.

GENERAL DISCUSSION

Overall, the results of the three studies reported have important implications for general education. If frequency of responding is a critical predictor of academic performance outcomes (i.e., REAPS), and speed plus accuracy is a more sensitive measure of academic proficiency than accuracy alone, then fluency-enhancing methods and frequency-based measurement systems within traditional classrooms might lead to greater learner gains. Because accuracy-only measures are most commonly used in education, teachers may be less able to effectively evaluate their students' proficiency in basic skill areas. That is, with an emphasis solely on accuracy, response rate and time required to achieve fluency are overlooked as critical predictors of academic proficiency. As a result, students may be advanced to higher-level skill areas before true mastery is achieved on prerequisite skills. Although some students can perform skills to an accuracy criterion, they may be unable to perform these skills at a rapid pace. This deficit may impede their performance on standardized tests or in more complex skill areas, and lead to academic difficulties at higher-grade levels. The current findings suggest that a more comprehensive picture of academic proficiency requires the inclusion of frequency and accuracy measures.

As mentioned previously, educators adopting CBM methods depend upon the use of frequency measures rather than accuracy measures alone. However, mastery criteria continue to be based upon class norms or averages rather than upon the direct assessment of academic performance outcomes with each learner. In this way, fluency is defined as average performance rather than exemplary performance. Increasing overall academic achievement remains a strong commitment in this country. However, such a goal cannot be achieved when class averages remain the standard in education.

In contrast, PT holds exemplary performance as the standard. However, along with holding students to higher standards of achievement comes the task of devising instructional strategies that will enable all students to reach those standards. As such, educators at the primary grade levels must begin requiring true mastery (i.e., fluency) of basic component skills before allowing advancement to higher-level skills. True mastery must be measured in terms of accuracy plus speed requirements and defined in relation to specific performance standards obtained with individual learners (e.g., REAPS). Additionally, complex skills must be broken down into very basic component units and practiced until true mastery is achieved.

The current results offer a starting point for an effective measurement and analysis tool to use in general education classrooms. Firstly, frequency measures and standard charting practices lead to timely and effective decision-making by educators. Additionally, by collecting frequent (i.e., daily) frequency measures during skill acquisition, educators could compare training performance with other outcome measures so that learning patterns across students and skill areas could be discovered. Thus, more information regarding the instructional conditions that produce the greatest academic proficiency could be identified.

One general limitation of the studies reported above involves each participant's differential progression through the curriculum. For example, some participants had progressed through a significant proportion of the curriculum and thus possessed a large repertoire of basic skills in which fluency had been achieved. As a result, those participants engaged in naturally higher baseline rates of responding during the introduction of novel skill areas than participants who were not as far along in the curriculum. That is, the more experienced students were initially responding at frequencies closer to the fluency range and thus did not have to make as significant an increase to achieve fluency. It may be the case that baseline rates of responding prior to fluency training can predict REAPS. The relationship of base rates to academic performance standards is an area for future research we are currently pursuing.

The current results expand upon clinical and empirical work conducted in the areas of PT and CBM that emphasize direct measurement of behavior (i.e., frequency) as a basic assessment tool. In order for educators to better understand the conditions necessary for establishing and
maintaining overall academic proficiency, more research needs to be conducted in the areas of PT and fluency-based instruction. With more frequent and rigorous investigation, it may be possible to identify educational technologies where academic excellence is the norm rather than the exception. We hope that these studies will set the occasion for more research in this area.

REFERENCES


Red is a 15-year-old boy who is receiving services for severe emotional and behavioral problems in an outpatient day treatment facility in south Mississippi. He has been diagnosed with Bipolar Disorder and Oppositional Defiance Disorder. In addition to his therapy, he also receives academic instruction for reading, math, and English in a self-contained classroom in this facility. Red was placed in the 8th grade because of his chronological age, however his academic performance ranged from the second to third grade level. His academic deficiencies can be attributed to his truancy throughout his educational history.

Upon initial placement in the day treatment facility, Red's reading deficits were so severe that he was unable to identify letter sounds. A corrective, direct instruction, decoding reading program was implemented for 11 nonconsecutive months prior to his participation in this precision teaching project. He attended the day treatment program for 9 months, and then he was removed from the program because he was noncompliant with his medication and his parents neglected to participate in his treatment. After a 4-month leave, he was re-admitted to the day treatment facility and continued with the corrective reading program for two more months prior to beginning this precision project.

During the course of his participation in the corrective reading program, Red's progress was astounding, and certainly alleviated any doubts of his ability to learn. He was able to decode words on approximately a 2.7 grade level, but his reading rate was very slow and he made frequent errors.

Red's teacher began implementing this precision teaching project because it was a requirement in a class she taking towards her Master's degree. This was her first experience using precision teaching. Prior to implementing the intervention designed to increase Red's fluency and accuracy, baseline data were recorded for three consecutive days. He was instructed to read a passage while his teacher timed him for 1-minute and recorded the number of words he read correctly and incorrectly. His reading rate ranged from 12 to 14 words per minute with 5 to 9 errors. For this project, a reading error was recorded if the Red omitted, inserted, substituted, or mispronounced words. Hesitations for more than two seconds and self-corrects were also counted as errors.

After collecting Red's baseline data, his teacher decided to set the aim at 100 words per minute with fewer than 5 errors. The intervention designed to increase Red's fluency and accuracy was as follows:

1) The teacher read the reading selection to Red.
2) Red was directed to silently follow along as the teacher read, and circle with a pencil any words he did not recognize.
3) After the teacher read, she used direct instruction to teach Red the words he circled (e.g., The teacher would say, "That word is morning. What word?" and Red would say "morning.").
4) When she finished going over each word he circled, she prompted him to read the words on his own.
5) The teacher continued to review the words Red circled until he read the word correctly within one second. This usually required two to three learning trials for each word.
6) After he read each word correctly, the teacher prompted Red to read the passage as quickly as he could and timed him for one minute.
7) Red entered his own data on the logarithmic chart on the computer immediately after he was timed. His teacher guided Red to access the saved chart, insert the data points (one for correct words per minute and one for errors), and save the updated information.
8) Upon completion of this procedure Red was rewarded with time to play games on the computer.

After 4 sessions of using the above procedure, Red stated that he did not want to play on the computer as a reward. Instead, he said, he would rather spend that time practicing reading so that he could increase his speed. So, on the ninth session, a phase change was implemented. The instructional procedures the teacher implemented were the same with the following exceptions: Red's teacher rewarded his participation by allowing him and a peer to practice reading together. They took turns reading the same passage the teacher used for instruction that day. This extra practice lasted approximately 10 minutes.

On the first day of the last phase change (the 9th session), Red read 39 words per minute and continued to increase his reading rate each
session. By the 23rd session he surpassed his aim by reading 102 words per minute. Additionally, Red made fewer than 5 errors per minute throughout the duration of the last phase. This was a considerable leap from his first timing when he read 12 words correctly and made 7 errors.

Throughout this project, Red became increasingly more motivated to improve his reading rate and decrease his errors. He paid close attention to his teacher while she read aloud and made sure he marked each unfamiliar word. Initially the computer game time helped encourage Red's participation and compliance to instruction. However Red's continued success provided the needed motivation to practice reading, and external rewards became unnecessary.

Red finished this project by meeting the aim of one hundred words per minute with fewer than 5 errors. Red continues to ask for time to read aloud with his reading partner. His partner also wanted to chart his own progress, and this desire to increase reading fluency and plot data has spread to the rest of the students in his class.
Concurrently Teaching Multiple Verbal Operants
Related to Preposition Use to a Child with Autism

Amy King, Alison L. Moors, and Michael A. Fabrizio
Fabrizio/Moors Consulting

Because understanding prepositions is useful to students for many skills such as following directions, requesting, and expanding expressive and receptive language, children should learn how prepositions function in language. This chart shows the progress a child with autism made in learning multiple ways of responding with and to prepositions.

Joe began timed practice on prepositions on December 9, 2002, when he was 5-years and 3-months old. Joe received approximately six hours of in-home behavior analytic intervention therapy per week. Joe also attended a half-day preschool program at a comprehensive early childhood center providing inclusive educational services for children with and without disabilities.

Joe practiced prepositions through the See/Say, Hear/Do, and Hear/Touch learning channels on this same chart. By varying the learning channel during the timing, Joe was able to improve concurrently his expressive (See/Say) and receptive (Hear/Touch) labeling of prepositions and his following directions that included prepositions (Hear/Do). Each day of practice, Joe's tutor set for him a daily improvement goal that he needed to reach in order to obtain his choice of rewards and finish working on the skill for the day.

Because we designed this skill using three different learning channels, Joe's tutor had to do change the cues she used during each timing-she had to ask Joe to identify the location of objects relative to one another ("Where is the glass?"). to touch items ("Find the item that is under the book."), and to place objects in relation to one another ("Put the pen behind your chair."). To avoid inappropriate stimulus control, the tutor varied the objects and the placement of the objects she used during the timing. His tutor used small toy figurines and any objects that Joe could put things in, on, or under for the initial slice. For example, Joe's tutor may have used a box and the lid of the box and said to Joe, "put the dog in the box." Once Joe put the dog in the box, the tutor would then give Joe another direction and vary the object as randomly as they could to avoid any pattern.

The first slice of the chart included the prepositions "in," "on," and "under." Joe completed two to three timings per day to reach his daily improvement goal. He began the slice at 18 corrects per minute and two errors per minute. His corrects accelerated at X1.9 across the four days of timed practice to their high and ending frequency of 34 per minute, and bounced at X1.3. Joe's errors remained steady across the phase at X1.0. Because of Joe's steep acceleration in his corrects, his tutor moved to slice two, in which she added the preposition, "behind." Joe's rate of correct responding jumped down by /1.43 and turned down (/1.8). Joe met his daily improvement goal in one to two timings during this phase. Christmas break occurred for one week during this phase, but Joe's performance maintained after this break.

Joe's tutor next added three new prepositions in the next phase of the chart—"in front", "between", and "beside" or "next to." At the start of this phase, Joe's rate of correct responding did not jump, but turned up by X1.04 from the previous phase. Joe's rate of incorrect responding also did not jump with the phase change, but did turn up by X1.74 from the previous phase. Joe required three timings per day during this phase to reach his daily improvement goal. Joe's corrects reached a high and ending frequency of 36 per minute with four errors per minute in seven days of practice across five weeks.

In the next phase of the chart, Joe's tutor added the preposition "over." Here, again, his corrects did not jump with the start of the phase change, but did turn down by /1.49. Joe's errors jumped down at the start of the phase but turned up (X2.0) as the phase progressed across the four days of timed practice. Joe practiced for three days and ended with corrects at 28 per minute with two errors. He required three timings per day to reach his goal during this phase. Joe went on vacation for one week towards the end of the phase.

When Joe returned from vacation, his tutor decided to evaluate the fluency of Joe's performance because she was unsure what an appropriate frequency aim might be for this skill. If Joe's performance to date showed the features of fluent performance-retention, endurance, stability, and application-then there was no reason to continue daily timed practice on the skill.

Joe's tutor first completed an endurance check on Joe's performance. To do this, she tripled the timing interval to 90 seconds and presented Joe with the same materials. Joe maintained his rate of 34 corrects per minute and four errors per minute errors in one timing. After passing the endurance check, his tutor moved to a 30-second stability check to evaluate his performance in the presence of significant distractions. For the stability check timing, Joe's mother was in the kitchen (Joe is easily distracted from work when his mother is present), and the tutor played with one of Joe's

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favorite toys during the timing. Joe passed his stability check at 30 corrects per minute and a drop down in his rate of incorrects. Next, Joe completed an application check. For the application check, his tutor asked Joe to identify prepositions in pictures within a book instead of using actual objects as they had been doing throughout the course of the chart. Joe passed his application check at 30 corrects per minute with zero errors on his first timing. Finally, to assess the skill's retention, Joe's tutor stopped all timed practice on this skill for four weeks. After four weeks, Joe's tutor presented Joe with the materials from the final slice before checks started and had him resume timed practice on all prepositions. Joe completed one 30-second timing and achieved 30 corrects per minute with two errors per minute. The chart was stopped, and we and Joe and did a cheer!
Analog Analysis of Two Variables Related to the 
Joint Attention of a Toddler with Autism

Michael A. Fabrizio  
University of Washington  
Fabrizio/Moors Consulting  
Seattle, Washington

Kristin Schirmer  
Fabrizio/Moors Consulting  
Seattle, Washington

Elizabeth Vu  
Seattle Central Community College

Ami Diakite and Mari Yao  
University of Washington

Joint attention—the ability to alternate attention between people and objects (Adamson & MacArthur, 1995)—is important to both language and social development and children with autism often show deficits in joint attending skills (Charman, T., Swettenham, J., Baron-Cohen, Cox, A., Baird, G., & Drew, A., 1997; Mundy, 1995; Dawson, Meltzoff, Osterling, Rinaldi, & Brown, 1998); as an example, children with autism may have difficulty shifting their gaze between a person and a toy with which they are playing. This chart shows the results of our analysis of the gaze shifting performance of a toddler with autism under analog conditions designed to test the affects of two variables on the child’s joint attention: toy manipulation demands and the child’s preference for the toy. We present this chart to document how precision teachers might display data collected during analog analyses on the Standard Celeration Chart and to describe clinical procedures for evaluating the effects of two variables on learner performance.

Diagnosed with Autism, Amir was 2-years and 9-months old when this chart began and had been receiving four hours per day of intensive in-home intervention services for one month. His in-home intervention team consisted of the authors listed above. During a language evaluation, Amir’s Speech Language Pathologist noticed he seemed to have difficulty shifting his attention (i.e., moving his head and eyes) from toys he played with to people in his immediate environment. Amir’s Speech Language Pathologist suspected that Amir experienced this difficulty shifting attention because of the manipulation demands the toys presented. She hypothesized that he was unable to “break” his attention from toys to attend to adults around him when the toys required a great amount of manipulation. She suggested Amir receive daily formal intervention in shifting attention as part of his in-home intervention program because of his apparent difficulty with shifting attention and its developmental importance.

Rather than beginning intervention right away, however, we chose to examine more closely and systematically whether the amount of manipulation a toy required affected Amir’s attention shifting. Because we suspected Amir’s preference for various toys might also influence how frequently he shifted his eye gaze away from them, we also analyzed how his preference for a toy affected his attention shifting at the same time that we evaluated the effects of toy manipulation.

We began by generating a list of toys for which Amir showed a high preference and a list of toys for which he showed little or no preference by considering how frequently he chose to play with a given toy and how long he interacted with it. If he interacted with a toy for long periods and consistently chose to play with it, we classified the toy as Highly Preferred. If he did not play with the toy for long periods or rarely chose to play with it, we classified the toy as Less Preferred. We then classified each of the same toys according to the degree of manipulation they required by considering several factors: the number of moving parts on each toy, the number of ways he could move the parts, and the size of the toy’s parts. For example, because picture books consist of a few, large parts (pages) that Amir could only turn, we classified books as requiring a low level of manipulation. A Busy Beads toy, by contrast, consists of many small moving parts that Amir could move in a variety of ways; therefore, we classified Amir’s Busy Beads toy as requiring a high level of manipulation. Once we classified each toy according to manipulation requirements and perceived preference, we subdivided the toys into four categories: (1) Highly Manipulative and Highly Preferred toys, (2) Less Manipulative and Highly Preferred toys, (3) Highly Manipulative and Less Preferred toys, and (4) Less Manipulative and Less Preferred toys. We used these categories as the four experimental conditions for the project.

After we generated our toy lists, we evenly distributed four sessions, each 2.5-minutes long, throughout Amir’s daily intervention schedule. During each of these 2.5-minute long sessions, we conducted the analysis. Each day, we gave Amir a toy from each list for 2.5 minutes. During those 2.5 minutes, a member of Amir’s intervention team (usually the third or fourth author) said Amir’s name aloud every 60 seconds. The staff member counted one attention shift if Amir looked up from the toy he was playing with within two seconds after hearing his name. If he did not look towards
were given to Amir varied randomly each day to ensure the order in which the toys were presented. Staff members only requested that Amir look once per minute, and each session lasted only 2.5 minutes, the maximum counted shifts in attention he could emit was two. Because detecting differences between such low rates of behavior would be very difficult if plotted as per minute frequencies each day, we plotted the data cumulatively.

We employed the Quarter-Intersect procedure (Koenig, 1972 as cited in White & Haring, 1980) to calculate acceleration values for each of the four experimental conditions. Amir’s attention shifting accelerated at a rate of X1.9 per week during the Highly Manipulative and Highly Preferred condition. During the Less Manipulative and Highly Preferred condition, Amir’s attention shifting changed at a rate of X1.8 per week. In the Highly Manipulative and Less Preferred condition, his attention shifting accelerated at a rate of X2.0 per week, and during the Less Manipulative and Less Preferred condition, it accelerated at a rate of X1.6 per week.

His attention shifting performance changed faster within both conditions where he played with highly manipulative toys (X1.9 and X2.0) than in either condition using less manipulative toys (X1.8 and X1.6). When the manipulation demands of the toy were kept constant and low (that is, during both the Less Manipulative and Highly preferred and the Less Manipulative and Less Preferred conditions), his attention shifting performance was better with highly preferred toys (X1.75) than with less preferred toys (X1.55).

Based on these differences, we concluded that the level of manipulation demand presented by a toy most influenced Amir’s attention shifting—the more manipulative the toy, the better his attention shifting performance. This conclusion refuted the hypothesis his Speech Language Pathologist originally developed during her clinical examination. We also learned that toy preference affected Amir’s attention shifting, but to a lesser degree than toy manipulation. When toys required less manipulation, toy preference did affect his performance—Amir shifted his attention more frequently with highly preferred toys than less preferred toys when the toys themselves presented lower manipulation demands.

Figure one below shows Amir’s rate of shifting attention plotted as cumulative frequencies by condition. Because staff members only requested that Amir look once per minute, and each session lasted only 2.5 minutes, the maximum counted shifts in attention he could emit was two. Because detecting differences between such low rates of behavior would be very difficult if plotted as per minute frequencies each day, we plotted the data cumulatively.

Beyond helping us decide not to intervene with Amir’s attention shifting, had we instead found that his performance did warrant intervention, having evaluated the variables’ effects on his performance would have provided another benefit: the data would have allowed us to evaluate the effects of any intervention we developed.

Further, the baseline data we gathered when we evaluated the two variables separately also gave us a good deal of information about which variable exerted functional control over Amir’s attention shifting as well as interactions that existed between the two variables. We learned that the manipulation opportunities toys offered were more important than Amir’s preference for the toys in controlling his attention shifting. We also learned that this control appeared to work in an opposite way from what we originally hypothesized.

We hope clinicians working with children with autism will invest the time needed to collect baseline and functional assessment data prior to designing and implementing an intervention. Collecting the data for this project took a total of 100 minutes (40 sessions at 2.5 minutes per session). The analysis took very little time, was easy to do, and produced quite a bit of information that helped us make better decisions on Amir’s behalf.

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Single vs. Multiple Movement Frequencies: How Many Times Should We Measure?

Dana J. Stevens  
University of Washington

The purpose of this chart share is to look for more efficient ways of monitoring a learner's progress. I decided to compare progress records based on a single opportunity to complete complicated task with a progress record based on multiple opportunities to compare the same task.

The learner, Sam, was an 8-year-old boy with autism who was fully integrated into a regular 2nd grade classroom. The goal of this intervention was to teach Sam how to put on his coat independently. To begin, a 12-step task analysis was created and the method of most-to-least prompting selected. During the course of the program, a picture script of the task analysis and peer modeling methods were also used. Instruction took place during naturally occurring school opportunities to put on his coat (e.g., preparing to go outside for recess, preparing to go home for the day). Sam's parents also worked with him at home using the same task analysis.

Three methods of monitoring the learner's progress (Figure 1) were implemented throughout the program: (1) Single-movement frequencies involved charting a single opportunity to complete the task each day. Time to completion was recorded and additional prompts were counted as errors. (2) Multiple-movement frequencies were also recorded daily and involved charting total opportunities and the cumulative time to complete putting on his coat across all opportunities. (3) Weekly parent reports were conducted to evaluate the family's satisfaction with their son's skill development.

Single and multiple movement frequencies showed similar rates of progress and occasioned the same instructional decisions, so it appears that a little effort could have been saved by evaluating his progress only once each day. That may not always be the case, however, so I'd recommend that single and multiple-movement frequencies both be charted when beginning a program. If the two charts show the same learning picture, the multiple movement chart could be dropped to save time and effort. If the two pictures are different, you might want to keep the multiple-movement chart to get a more complete picture of learning.

In addition, I was pleased to note that the parent's report of his progress at home confirmed that he had learned something useful and was using his new skill in places where it was important. It is my recommendation to gather the same type of feedback whenever possible.

For the Single Movement Frequency:

\[
\text{Correct Frequency} = \frac{1}{\text{Time Required to Complete the Task Once}}
\]

\[
\text{Error Frequency} = \frac{\# \text{ of Extra Prompts}}{\text{Time Required to Complete the Task Once}}
\]

For the Multiple Movement Frequency:

\[
\text{Correct Frequency} = \frac{3 \text{ (the number of times the task was completed)}}{\text{Cumulative Time Required to Complete All 3 Trials}}
\]

\[
\text{Error Frequency} = \frac{\# \text{ of Extra Prompts}}{\text{Cumulative Time Required to Complete All 3 Trials}}
\]

Figure 1: Three methods of monitoring the learner's progress
Puts on Coat

* = Coat On;
x = Extra Prompts Needed

Change coat from fleece to heavy winter coat with hood

Peer modeled task in previous practice

Discontinued PEC script

No practice at school
Broken arm in cast

Parents satisfied, can be independent, can put coat on independently
Parents satisfied w/program, assistance is minimal
Parents satisfied w/program, but can still use support for help when appropriate
Parents not satisfied yet, with program, have not seen change at home

Owen White  Dana Stevens
Name of School  School Staff  School Staff  Dana  Coats-On & Extra Prompts

Successive Calendar Days
S.B.  8 years  Autistic
Journal Description

The Standard Celeration Society publishes the Journal of Precision Teaching and Celeration (JPTC) two times a year. JPTC provides a forum for research, practical applications and discussions of Precision Teaching and Celeration technology. JPTC has dedicated itself to the promotion and diffusion of Precision Teaching and Standard Celeration technologies.

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(1) Use of Standard Celeration Charts;
(2) Use of basic charting conventions;
(See the JPTC guidelines for guidance on the “basic charting conventions”);
(3) Description of variables or procedures supporting the interpretation of the data.

“Application articles” usually represent data from applied settings such as schools, clinics, human service agencies.

II. Research Articles: “Research articles” require:
(1) The use of Standard Celeration Charts;
(2) Descriptions of the collection and analysis of data;
(3) Use of basic and advanced charting conventions and analysis;
(See the JPTC guidelines for guidance on the “basic” and “advanced” charting conventions and analysis);
(4) Description of variables or procedures supporting the interpretation of the data;
(5) Control for extraneous variables or report of their influence.

III. Discussion Articles: “Discussion articles” offer explanations, reviews, and extensions of Precision Teaching and Standard Celeration concepts.

IV. Chart Shares: “Chart shares” contain data displayed on Standard Celeration Charts along with brief descriptions of the performer, what occurred, and other relevant observations.
[Note: We encourage performers (e.g. students, clients, patients) to submit their own charts to the chart share section.]

V. Technical Notes: Brief technical descriptions clarifying, elaborating, or reporting upon Precision Teaching and Standard Celeration concepts.

Submission Guidelines:

To submit a manuscript authors must conform to the following guidelines:
(1) Submit three (3) typewritten, doubled spaced copies of the manuscript without author’s names or affiliations;
(2) Follow the format outlined in the Publication Manual of the American Psychological Association (5th edition, 2001);
(3) Do not exceed 20 words in the article title;
(4) Include an abstract and do not exceed 250 words in the abstract;
(5) Select 3 to 5 key words that describe the manuscript;
(6) Secure permission for use of copyrighted materials;
(7) Send submissions to: Dr. Richard M. Kubina Jr., The Pennsylvania State University, Department of Educational and School Psychology and Special Education, 231 CEDAR Building, University Park, PA 16802-3109.

The Editors reserve the right to edit all material accepted for publication.
**BASIC CHARTING CONVENTIONS for the DAILY STANDARD Celeration Chart**

<table>
<thead>
<tr>
<th>TERM</th>
<th>DEFINITION</th>
<th>CONVENTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. CHARTED DAY</td>
<td>A day on which the behavior is recorded and charted.</td>
<td>1. Chart the behavior frequency on the chart on the appropriate day line.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2. Connect charted days except across phase change lines, no chance days and ignored days.</td>
</tr>
<tr>
<td>a) ACCELERATION TARGET</td>
<td>Responses of the performer intended to accelerate.</td>
<td>Chart a dot (●) on the appropriate day line.</td>
</tr>
<tr>
<td>FREQUENCY</td>
<td></td>
<td></td>
</tr>
<tr>
<td>b) DECELERATION TARGET</td>
<td>Responses of the performer intended to decelerate.</td>
<td>Chart an (x) on the appropriate day line.</td>
</tr>
<tr>
<td>FREQUENCY</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. NO CHANCE DAY</td>
<td>A day on which the behavior had no chance to occur.</td>
<td>Skip day on daily chart.</td>
</tr>
<tr>
<td>3. IGNORED DAY</td>
<td>A day on which the behavior could have occurred but no one recorded it.</td>
<td>Skip day on daily chart. (Do not connect data across ignored days.)</td>
</tr>
<tr>
<td>4. COUNTING-TIME BAR</td>
<td>Designates on the chart the performer's lowest possible performance (other than zero) in a counting time. Always designated as &quot;once per counting time.&quot;</td>
<td>Draw solid horizontal line from the Tuesday to Thursday day lines on the chart at the &quot;counting-time bar.&quot;</td>
</tr>
<tr>
<td>(aka Record Floor)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5. ZERO PERFORMANCE</td>
<td>No performance recorded during the recording period.</td>
<td>Chart on the line directly below the &quot;counting-time bar.&quot;</td>
</tr>
<tr>
<td>6. PHASE CHANGE LINE</td>
<td>A line drawn in the space between the last charted day of one intervention phase and the first charted day of a new intervention phase.</td>
<td>Draw a vertical line between the intervention phases. Draw the line from the top of the data to the &quot;counting-time bar.&quot;</td>
</tr>
</tbody>
</table>