

## Looking at Magnitude of Reinforcement and Its Effect on Academic Progress

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Students at The Judge Rotenberg Center can earn money for mastering lessons on academic computer programs. This money can be spent on various rewards, to include shopping, take-out food, sporting events and many other things. The money is automatically placed into the students' account, when they earn it. Mastery is determined on an individual basis and the amount of money earned for a mastered lesson is also determined on an individual basis. These decisions are based from the data created when the students complete timings. We will be looking at the effect that different values of reinforcement have on the number of timings that students complete and the number of lessons mastered. Originally, students received a fixed amount of money every single time they achieved their pre-set level of mastery. We then made an intervention where the magnitude of the reinforcer varied for each lesson mastered, which was determined by computer algorithm. During this study we will be looking to see whether the fixed magnitude schedule or the variable magnitude schedule of reinforcement had greater impact on the number of timings completed and the number of lessons mastered.

### **Method**

#### **Participants and Setting**

This study a total of 23 participants. Ages ranged from 12.3 to 19.2. Participants had varying diagnoses, such as Oppositional Defiance Disorder, Attention Deficit Hyperactivity Disorder, Mood Disorder, Anxiety and Expressive/Receptive Language Disorder.

All participants attended school at the Judge Rotenberg Center. Classrooms were comprised of up to 8 students, with one teacher and up to two aides.

#### **Measures and Instruction**

As reinforcement to regular mathematics instruction, participants completed timings in the Math Facts program, which is proprietary software developed at the Judge Rotenberg Center. This software helps increase fluency in basic math facts, in the areas of addition, subtraction, multiplication and division. Participants also completed timings in the Spelling program, which is another proprietary program developed at the Judge Rotenberg Center. This program increases fluency in spelling words from a kindergarten to a twelfth grade level. Both programs have a host of settings, which can personalize the program for the user. This includes the number of questions presented, length of timing, visual cues and audio cues, and error correction. We are also able to set the required rate of response for correct and incorrect answers that will allow the user to master the lesson and move onto the next lesson.

For the purpose of this study, we looked at magnitude of reinforcement in conjunction with the number of timings a participant completed and the number of lessons mastered. Before this

study, participants were able to earn a fixed amount of money for mastering a lesson. This happened automatically on the participant's computer; therefore when they mastered a lesson, a pre-determined dollar amount was deposited into their account. The monetary reward was determined by education staff or treatment staff. Rewards ranged from \$0.15 to \$1.00. The reward was delivered each time a participant mastered a lesson. This money was spent on various rewards to include ordering take-out food, shopping for clothes and electronics. The participants' accounts were also tied to their inappropriate behaviors. If a participant exhibited a pre-determined (by the treatment team) behavior, they would lose a pre-determined amount of money. Also, if a participant destroyed property, they would be required to pay for the item from the money in their account.

Rewards were then switched to a variable magnitude; with the amount of money a participant could earn for lesson mastery changing each time they mastered a lesson. The magnitude changed several times; this was due to low levels of responding and then due to high levels of money earned. Below is the money allocations for the fixed and variable magnitude of reinforcement.

#### Fixed Magnitude Rewards

Lowest Amount Earned for Lesson Mastery	Average Amount Earned for Lesson Mastery	Highest Amount Earned for Lesson Mastery
\$0.15	\$0.44	\$1.00

#### Phase 1-Variable Magnitude Rewards

Participants could go into debt.

Amount Earned	Ratio (Timings: Overall Timings)
\$.00	49:100
\$0.05	20:100
\$0.10	10:100
\$0.25	6:100
\$0.50	5:100
\$0.75	4:100
\$1.00	3:100
\$5.00	2:100

#### Phase 2-Variable Magnitude Rewards

Participants' debt is wiped out.

Amount Earned	Ratio (Timings: Overall Timings)
\$.00	49:100

\$0.05	20:100
\$0.10	10:100
\$0.25	6:100
\$0.50	5:100
\$0.75	4:100
\$1.00	3:100
\$5.00	2:100

**Phase 3-Variable Magnitude Rewards**

<b>Amount Earned</b>	<b>Ratio (Timings: Overall Timings)</b>
\$0.50	37.5:100
\$1.05	12.5:100
\$2.50	25:100
\$5.00	12.5:100
\$7.50	12.5:100
\$25.00	2:100

**Phase 4-Variable Magnitude Rewards**

<b>Amount Earned</b>	<b>Ratio (Timings: Overall Timings)</b>
\$0.05	4:100
\$0.10	4:100
\$0.25	10:100
\$0.35	10:100
\$0.50	8:100
\$0.75	7:100
\$1.00	7:100
\$1.75	10:100
\$2.50	10:100
\$3.75	5:100
\$5.00	5:100
\$6.25	5:100
\$7.50	5:100
\$8.75	4:100
\$10.00	2:100
\$12.00	2:100
\$18.00	1:100

**Phase 5-Variable Magnitude Rewards**

<b>Amount Earned</b>	<b>Ratio (Timings: Overall Timings)</b>
\$0.05	8:100
\$0.10	8:100
\$0.15	8:100
\$0.25	11:100
\$0.35	11:100
\$0.40	11:100
\$0.60	11:100
\$0.75	9:100
\$1.00	8:100
\$1.50	4:100
\$2.00	2:100
\$3.00	2:100
\$5.00	1:100
\$6.00	1:100
\$7.00	1:100
\$10.00	1:100
\$12.00	1:100
\$18.00	1:100
\$25.00	1:100

## **Results**

We looked at data for approximately fifty-six days from when participants were on a fixed magnitude reward system. The most a participant earned for lesson mastery was \$1.00; the least a participant earned was \$0.15. For Spelling, the total number of timings completed was 3,903 and the total number of lessons mastered was 598. For Math Facts, the total number of timings completed was 2,362 and the total number of lessons mastered was 433. Mastery of a lesson was determined by the teacher. They set an aim for the participant and they must meet that aim in a pre-set amount of time, typically one minute. The average aim for Math Facts is set at a rate of 60 correct responses and one incorrect response in one minute. For Spelling, the average aim is set at 20 words correct and one incorrect in one minute in order to be considered mastery.

We then looked at data for fifty-six days after the participants were on the variable magnitude reward system. In Spelling, the twenty-three participants completed a total of 10,333 timings and mastered a total of 3,287 lessons. This is a 165% increase in timings completed and a 659% increase in timings mastered. For Math Facts, the twenty-three participants completed a total of 3,395 timings and a total of 729 lessons were mastered. This is a 44% increase in timings completed and a 68% increase in lessons mastered.

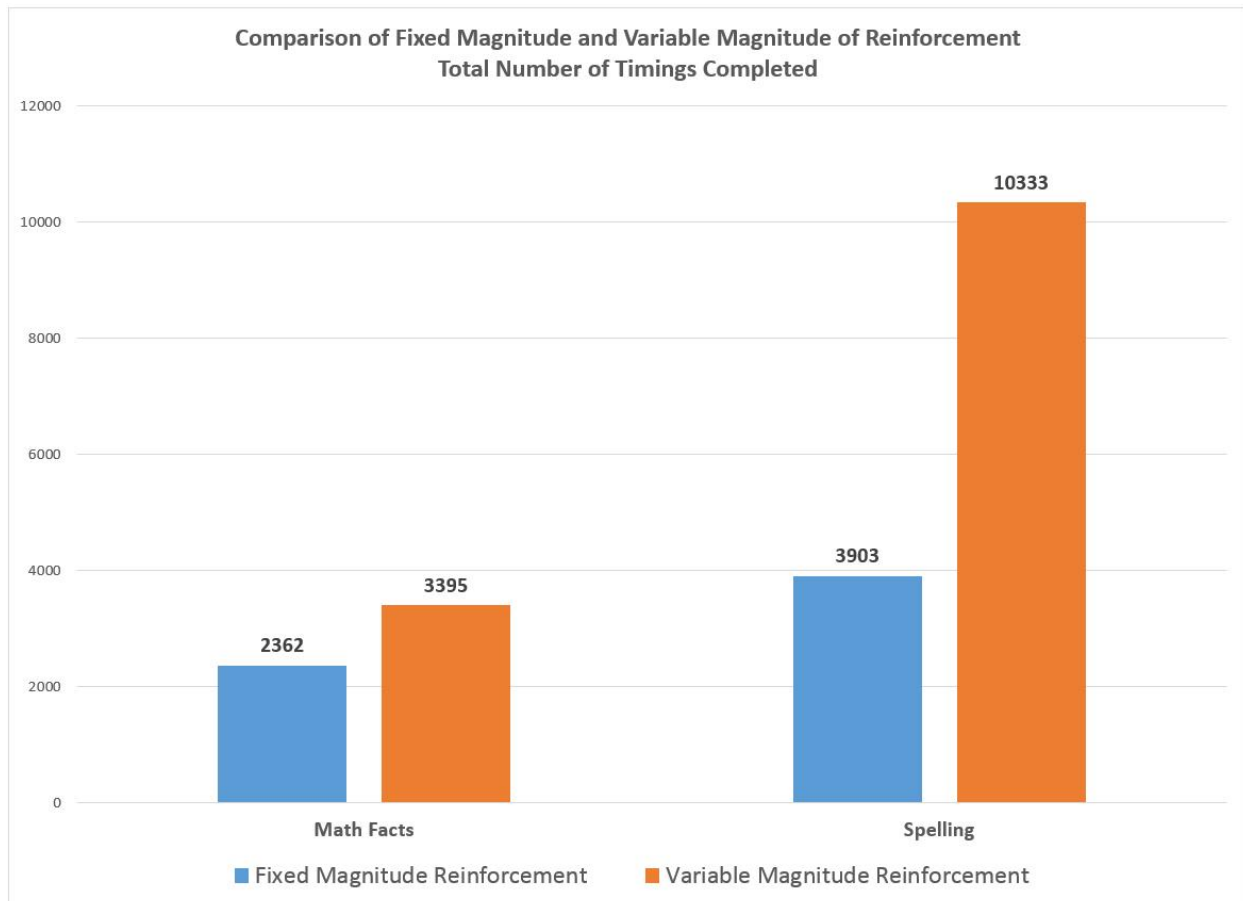
Participants were in Phase One for thirty-two days. For Spelling, the total number of timings completed was 1,630 and total lessons mastered 400. In Math Facts, the total number of timings completed was 902 and total lessons mastered were 241.

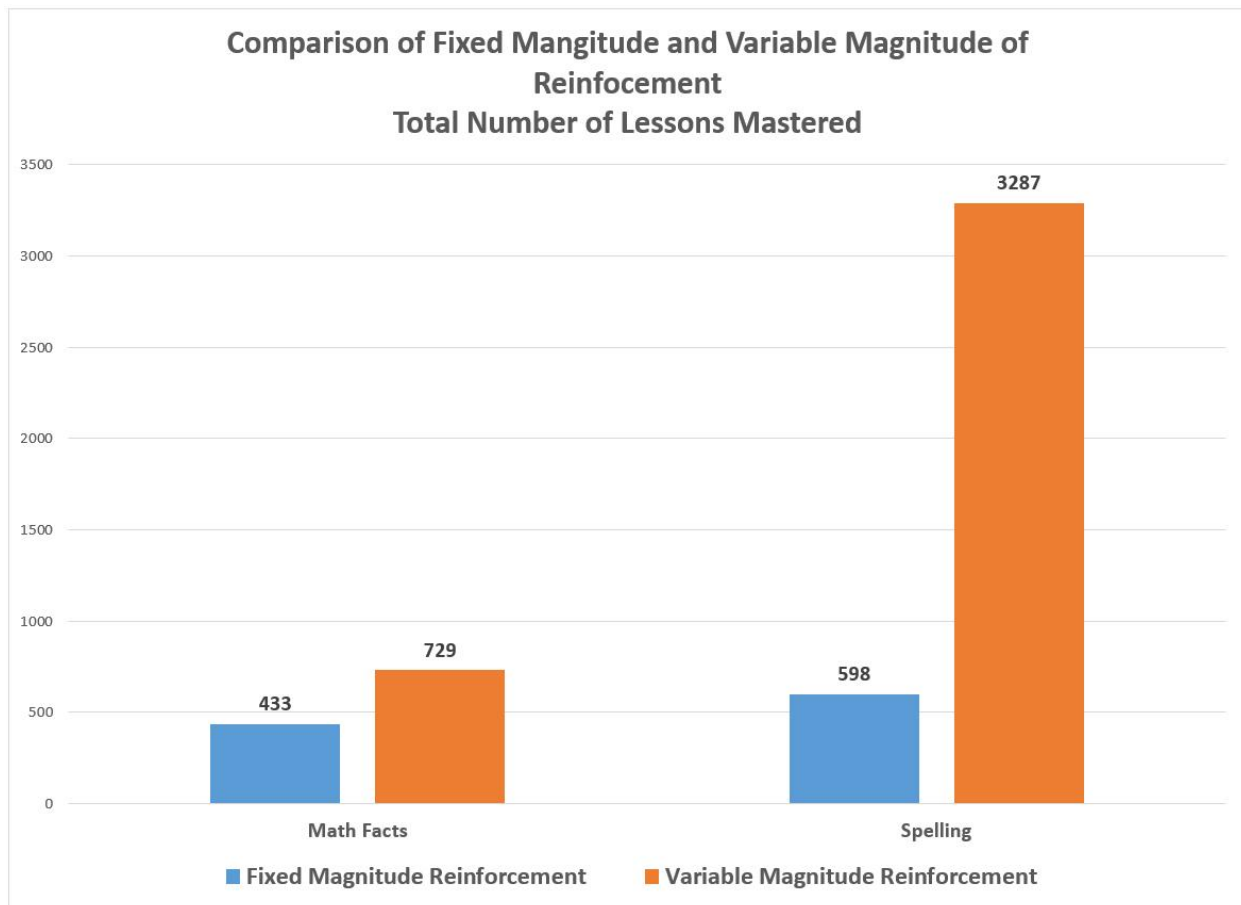
Participants were in Phase Two for ten days. For Spelling, the total number of timings completed was 1,840 and the total number mastered was 587. In Math Facts, the total number of lessons completed was 650 and the total number of lessons mastered was 95.

Participants were in Phase Three for one day. For Spelling, the total number of lessons completed was 612 and the total of lessons mastered was 227. For Math Facts, the total number of lessons completed was 207 and the total number of lessons mastered was 32.

Participants were in Phase Four for four days. For Spelling, the total number of lesson completed was 3,176 and the total number of lessons mastered was 1,096. For Math Facts, the total number of lessons completed was 487 and the total number of lessons mastered was 105.

Participants were in Phase Five for nine days. For Spelling, the total number of lessons completed was 3,075 and the total number of lessons mastered was 977. For Math Facts, the total number of lessons completed was 1,149 and the total number of lessons mastered was 256.





### **Discussion**

The data shows us that students had a much higher rate of timings completed in spelling than in math facts but overall, both showed significant growth. In Spelling, the fixed magnitude data showed us that the students completed a total of 3,903, which increased to a total of 10,333 after we varied the magnitude of the reinforcer. The total increase in lessons completed was 6,430. In Math Facts, the total number of lessons mastered in the fixed magnitude phase was 598 and increased to 3,287 during the variable magnitude phases. This was an increase of 2,689 timings mastered.

During the course of this study we altered the magnitude of the reinforcer five times. The reason this occurred was because we were looking for the right balance of money earned and lessons being mastered. In the first phase we miscalculated the number of timings completed and lessons mastered. This affected the amount of money that was given and the ratio that it was distributed, meaning that students were not being paid for every lesson that they completed. Often times they were paid nothing. We realized as we were observing that we were seeing a ratio strain. The effort in which the student had to respond was not balanced to the reinforcement provided. As a result, we again altered that ratio of the reinforcer to a fixed schedule, meaning they would be paid every time they mastered the lesson. We did not, however, change the requirements for mastery. We also provided a much higher and varied magnitude of reinforcement. This was done in order to have students receive an initial big pay out and then we quickly began reducing it.

After the second phase we began reducing magnitude which was not noticed as much by our students as the first phase was. We continued to see high rates of responding even though the amount of money was less. We also noticed that in two of the classrooms many students were still not motivated even with the teacher informing them of these changes until one of their peers actually earned the twenty-five dollar reward.

During this study we began to see many participants involved in figuring out ways to meet their academic goals, so that they could earn money. They asked their teachers to change their settings on the computer programs, so they could master more lessons. They emailed education staff to request interventions when they were stuck; whereas before, they might work on the same lesson for an extended period of time.

The variable magnitude of reinforcement has carried into other academic areas such as; vocabulary, history, Spanish etc. A problem area during the academic day was group lessons. Students would refuse to participate or exhibit behaviors that were disruptive during group lesson time. A ticket system was implemented, where students could earn tickets for exhibiting various positive behaviors, such as answering questions, staying on task, or positive peer interaction. Each student also earned a special ticket for meeting an individual goal set by their teacher or education staff. At the end of the group lesson, the special tickets were combined and one was randomly chosen. This earned them a high value reward, such as money in their account; this high value reward changes daily. The tickets given during the lesson were also traded for academic money. The magnitude of the reinforcer for the ticket was the same for each one earned. However, the amount of tickets earned was dependent upon the student, we did not put a maximum number of how many tickets they could earn. These tickets have been very motivating and have caused a large decrease in off topic behaviors during group lessons and a high increase in student participation and on topic questions during group lessons.

The data from this study has shown us that the variable magnitude reward schedule can be very motivating for students. It has also shown us the importance of ensuring that the participants are motivated by what they are earning. We plan to continue using the variable magnitude reward schedule and examining its effect on different academic tasks; as well as the variable ratio of reinforcement used with the ticket system.