HIGH SCHOOL EDITION
Journal of Student Research
Volume 11 Issue 2 (2022)

Teaching Approaches in Improving Visual-Spatial Pattern Recognition in Children with Down Syndrome

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ABSTRACT

Global Down Syndrome Foundation stated that "More research is needed to determine how to most effectively teach children with Down syndrome," (Development…) directly identifying a need for increased research in the respective field. A debate persisting surrounding which teaching style is most effective for children with Down syndrome will be addressed through the incorporation of a kinesthetic and visual approach to teaching visual-spatial constructs in an effort to find one so-called "best" form of teaching. Understanding whether a kinesthetic or visual approach to teaching is more beneficial for children with Down syndrome is a step towards revising an education system that oftentimes does not sufficiently educate children with special needs. This study seeks to assist in finding the most efficient ways to teach children with Down syndrome so that their education will become more effective and impactful.

Introduction

Visual-spatial intelligence regards an individual's ability to perceive patterns and picture concepts around them. Imagination greatly contributes to such capabilities, which can lead individuals with Down syndrome to struggle in visual-spatial awareness when compared to typically developing children of equivalent intelligence (Yang, 2014). Because teaching visual-spatial pattern recognition has been proven possible, a dilemma arises surrounding how to best accommodate for the intellectual deficit (Stander, 2019). It is claimed that every participant has a distinct combination of learning styles best suited for the way they process and understand information. The most common learning styles are the following: visual, aural, verbal, kinesthetic, logical, social, and solitary. The study conducted focuses on visual and kinesthetic teaching. Visual teaching surrounds the use of pictures, symbols, and visual displays to teach information. Kinesthetic teaching surrounds the incorporation of hands-on activities to portray information (Overview...).

Nine children ages six to seventeen with Down syndrome will complete a portion of the Spatial ISIQ Test, Children's Version, designed by Dr. William A. McConochie to measure spatial intelligence. This will be followed by individualized teaching lessons coinciding with the child's respective learning style group and results will be drawn surrounding the effectiveness of each teaching technique in comparison to one another as well as to a control group. The question sought to be answered is as follows: which category of teaching is more effective in terms of improving visual-spatial pattern recognition in children, ages six to seventeen, with Down syndrome: kinesthetic or visual?

Because it can be difficult for individuals with intellectual disabilities to express and interpret verbal information (Wilkinson, 2013), a non-verbal intelligence test will be administered in an effort to gain more accurate data. The ability to measure how much each child's capacity to visualize different patterns and theoretical movements is improved through teaching sessions centered on specific learning styles will offer insight as to what teaching methods are most effective for children with Down syndrome. This will assist therapists

and educational professionals in understanding which styles of teaching to integrate into their professions to best assist those with Down syndrome.

Literature Review

In order to best understand the applicability of a study surrounding the comparable effectiveness of a kinesthetic or visual approach to teaching children ages six to seventeen with Down syndrome in terms of visual-spatial pattern recognition, a substantial understanding of similar works must be achieved. Because a fact must be proven and/or verified in order to remain credible, several pieces of background information need to be established in order to back up my data. First, it needs to be proven whether or not Down syndrome can cause a struggle with visual-spatial pattern recognition. Secondly, both the advantages and disadvantages Down syndrome inflicts upon the minds of those affected need to be determined, in an effort to gain a better understanding of Down syndrome's overall impact. Next, the concepts of learning/teaching styles must be verified and proven to hold reasonable accuracy. Lastly, a specific approach must be created to incorporate all of the previously known data surrounding children with Down syndrome's ability to perceive patterns and shapes with new data being collected surrounding specifically how to improve such skills causing each child difficulty.

Studies surrounding visual-spatial pattern recognition and memory have been conducted, as well as studies surrounding the effectiveness and applicability of different teaching methods. However, little research has been done in regards to a combination of such two categories; how to best teach children with Down syndrome, emphasizing a focus on visual-spatial pattern recognition and memory, remains unknown.

A study conducted by Vicari, Bellucci, and Carlesimo makes use of a neurological approach to understanding the visual-object and visual-spatial memory capabilities of individuals with Down syndrome. Comparing ten males in an experimental group to seven males in a control group, all of whom have Down syndrome, the experimenters discovered the individuals had a substantially more difficult time with visual-object patterns than visual-spatial sequences. Linking Down syndrome to cognitive impairment in terms of memory retainment and visual-object pattern recognition, this study proves crucial in laying the framework for my study (Vicari, 2005). An additional study by Bostelmann, Costanzo, Martorana, Menghini, Vicari, Lavenex, and Lavenex seeks to prove individuals with Down syndrome face deficits in regards to configurable or spatial relationships. This study overall assesses the ability of individuals with Down syndrome to perform low resolution spatial learning, which they found by comparing the learning system in an individual to the response learning system. While Down syndrome is commonly associated with intellectual deficits, some areas of the brain are more drastically affected, such as language skills and verbal short-term memory (Bostelmann, 2019). Again seeking to determine whether or not individuals with Down syndrome excel or struggle in specific categories of memory compared to others, a similar study was conducted by Costa, Purser, and Passolunghi. Their study surrounded measuring the working memory and short-term memory of patients with Down syndrome in comparison to people of similar intellect, primarily focusing on the psychological perspective of the issue rather than the neurological perspective. Two Down syndrome patients, aged fifteen and seventeen at the time of the study, were initially given Raven's Colored Progressive Matrices test and the third edition of the British Picture Vocabulary Scale 3 test in an effort to find which ways of teaching best assist in preserving memory for Down syndrome patients. Raven's Colored Progressive Matrices measure abstract reasoning and are considered to estimate the non-verbal fluid intelligence of an individual, while the British Picture Vocabulary Scale 3 test assesses the receptive vocabulary of an individual. Such studies were used in an effort to form a baseline to which typically developing children within similar ranges of non-verbal intelligence could be compared. Participants were tested in multiple categories: visuo-spatial working memory, verbal short-term memory, and verbal working memory, followed by visuo-spatial working memory training through the form of visa-spatial working and short-term memory games (Costa, 2015). This study cements the idea that visuo-spatial memory training will

improve visa-spatial working and short-term memory within Down syndrome patients, a crucial structural component pertaining to my study.

Sufficient studies have been conducted surrounding the usefulness of different methods of teaching in improving memory within typically developing participants. A study conducted by Khanal, Giri, Shah, Koirala, and Rimal surrounding the preferred learning-styles of first year pre-clinical students discovered the most beneficial use of teaching methods is to individually cater to each child. This study, in particular, was conducted using one hundred and forty-two first year Bachelor of Medicine, Bachelor of Surgery, and Bachelor of Dental Surgery students, ultimately finding that 53.52% of the students were multimodal, meaning they preferred a combination of teaching styles rather than just one (Khanal, 2019). This study also concluded that there is no statistical significance surrounding a connection between learning styles and sex, nationality, or academic performance, an additional needed establishment for my study. Overall, this study proved that different methods of teaching can determine how effectively information is absorbed, demonstrating the idea that it is valuable to understand when and how to use different teaching methods. Another study, conducted by Jessica Stander, Karen Grimmer, and Yolandi Brinkdelves into this similar concept surrounding the importance of using individualized teaching techniques to better deliver information to students. Because no two children prefer identical combinations of teaching, discovering which teaching methods are most common would allow for teachers to best incorporate teaching techniques most beneficial to the majority of their students. The ability for teachers to incorporate specific teaching methods into their lesson plans is an incredibly useful skill as the teachers can best alter their lessons to accommodate the needs of their students (Stander, 2019).

Because it has been established that children with Down syndrome typically struggle in regards to visual-spatial pattern recognition and memory, I formulated a plan seeking to answer my initial question. My study will prove unique as it will specifically surround discovering whether or not certain teaching styles are more effective in improving visual-spatial pattern recognition in children with Down syndrome than other teaching styles. A kinesthetic and visual approach to teaching will be incorporated in an effort to find one so-called best form of teaching. Global Down Syndrome Foundation states “More research is needed to determine how to most effectively teach children with Down syndrome,” directly stating the gap I seek to address through my study.

A significant contribution to society will be made through this study as the gap surrounding how to most effectively educate children with Down syndrome will be filled. Understanding whether a kinesthetic or visual approach to teaching is more beneficial for children with Down syndrome is a step towards revising an education system that oftentimes does not sufficiently educate children with special needs. I seek to assist in finding the most efficient ways to teach children with Down syndrome so that education can become more efficient and impactful.

Methodology

Research Participants

Nine individuals (three males, six females) with Down syndrome aged six to seventeen (Age M=11, SD=2.83) were included in the study.

It is presumed that neither race nor socioeconomic background will have an effect on the results of the study. As the individuals “scores” are not being compared to one another in terms of accuracy or previous knowledge, each subject’s intellectual capabilities have been ruled out as a confounding variable. Instead, the answers are being used to display progress through forming a baseline and establishing growth surrounding the concepts, rather than seeking to interpret the individual’s intelligence.

Research Materials

The questions administered come from *The Spatial ISIQ – Children's Version* test, created by Dr. William A. McConochie to measure the intelligence of children ranging from intellectually challenged six year olds to gifted sixteen year olds. Because this study did not surround quantifying each individual's intelligence quotient, or IQ, neither the whole test, the established age range, nor the test's interpretations were necessary in this study. The test includes 208 multiple choice questions, each containing four answer choices and an "I don't know" option. The test covers content from five categories: everyday physics, worldly knowledge, patterns and shapes, directions, and common hand tools (McConochie). This study incorporates thirty-nine of the questions (numbers 1, 2, 3, 4, 7, 9, 10, 11, 12, 30, 33, 35, 42, 43, 44, 45, 46, 47, 48, 49, 50, 51, 52, 53, 54, 56, 57, 61, 65, 82, 85, 86, 88, 89, 99, 101, 103, 122, and 132), selected based off of their ability to represent the different groups of content covered in the original test.

A multitude of additional instruments are necessary in carrying out this study. As one method of teaching is entirely devoted to a kinesthetic approach, a hands-on representation of each concept must be created. Similarly, the second method of teaching, devoted entirely to visual displays, requires visual representations of each concept covered. The former reasons listed result in the incorporation of additional materials. Below is a complete list of tools/equipment used to convey each question in either a kinesthetic or visual manner.

Drawing paper, Pens/pencils/markers, Feather, Steel bolt, Candle, Apple, Analog clock, Pillow, Step stool, Box, Football, Rubber ball, Metal trophy, Ski, Varying lengths of thin scrap metal, Miniature blocks, Small rubber ball, Wash cloth, Bottle of water, Hair dryer, Liquid soap, Toy car, Piece of wood, String, Small metal block, Wheels varying in size (four of increasing width), String, Miniature weight, Glass of water, Straw, Small triangular platform, Small box of sand, Miniature plastic doll, Miniature plastic deer, Miniature plastic dog, Miniature plastic duck, Miniature plastic cow, Paper airplanes of varying wingspan (four of increasing length)

Research Design

This experiment involves no manipulation of variables but, rather, the addition of assistance to quantify memory growth. Each individual's second answer to each question, repeated after instruction of the topic was concluded, serves as the dependent variable as such responses signify the impactfulness of the teachings. The two methods of teaching, a kinesthetic and visual approach, serve as the independent variables in this study. The third group, receiving no form of teaching, serves as the control in this study.

The results will be interpreted by comparing each child's initial answers to their final answers, quantifying the improvement. The total number of correct answers out of the total number of questions through which the individual progressed will be compared in terms of their initial results versus their final results, formulating an overall percentage of improvement. Each of the three individuals in each group's percentages will be combined and averaged in order to find a collective rate of improvement. The averages will then be compared to one another in order to determine which of the teaching styles resulted in greater improvement.

Research Procedure

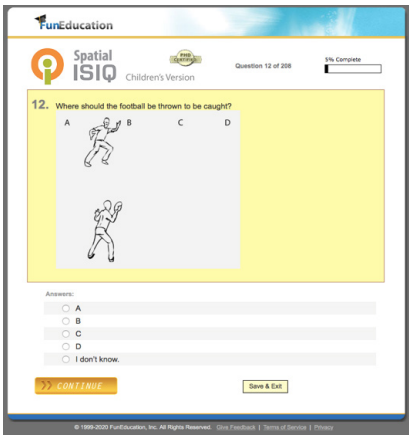

Figure 1. A sample question from McConochie's Kids spatial ISIQ QUIZ. The correct answer is B.

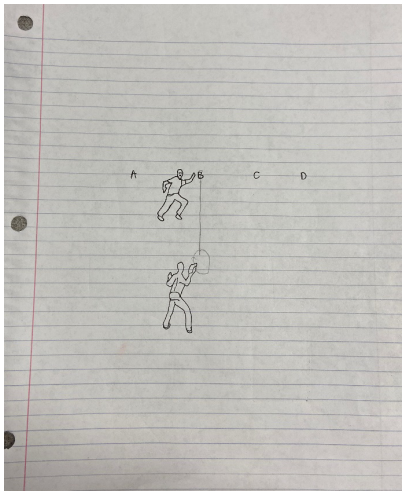

Figure 2. A sample kinesthetic approach to teaching the construct illustrated in Figure 1 is provided.

Kinesthetic Approach

The picture illustrated in *Figure 1* was copied onto a sheet of paper, identified in *Figure 2*. The participant was instructed to draw a line from the football to the person's hand, demonstrating the path best fit for the football to travel and, therefore, to which point the ball should be thrown.

Visual Approach

Similar to the kinesthetic approach, the picture illustrated in *Figure 1* was copied onto a sheet of paper, identified in *Figure 2*. The instructor drew a line from the football to the person's hand, demonstrating to the participant the path best fit for the football to travel and, therefore, to which point the ball should be thrown.

Hypotheses

Ha: A kinesthetic approach to teaching is more effective than a visual approach to teaching in improving visual-spatial pattern recognition.
Ho: There is no statistically significant correlation between teaching methods and improvement in visual-spatial pattern recognition.

Individual Results by Group

Control Group

Participant One

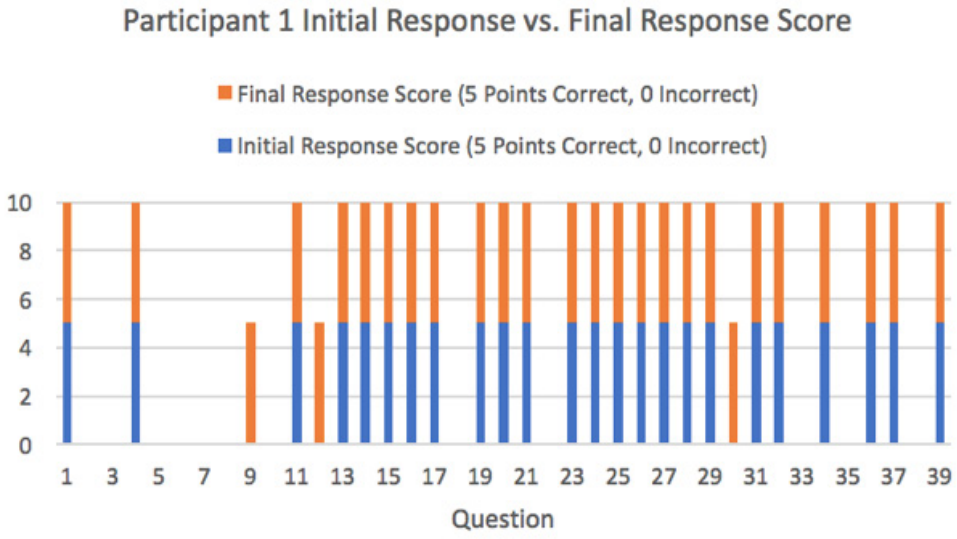

Figure 3. The table displays Participant One's responses. Incorrect answers are represented by a blank cell.

Participant Two

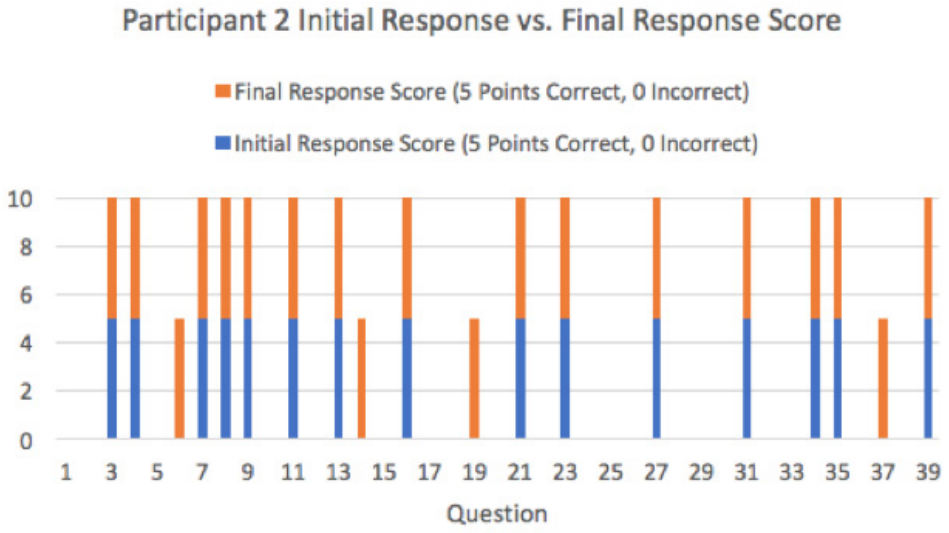

Figure 4. The table displays Participant Two's responses. Incorrect answers are represented by a blank cell.

Participant Three

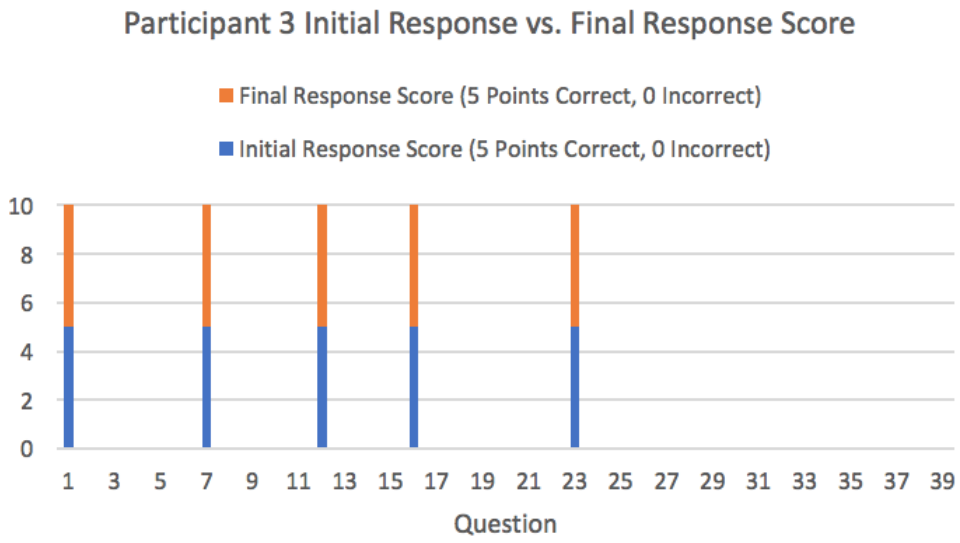

Figure 5. The table displays Participant Three's responses. Incorrect answers are represented by a blank cell.

Visual Approach Group

Participant Four

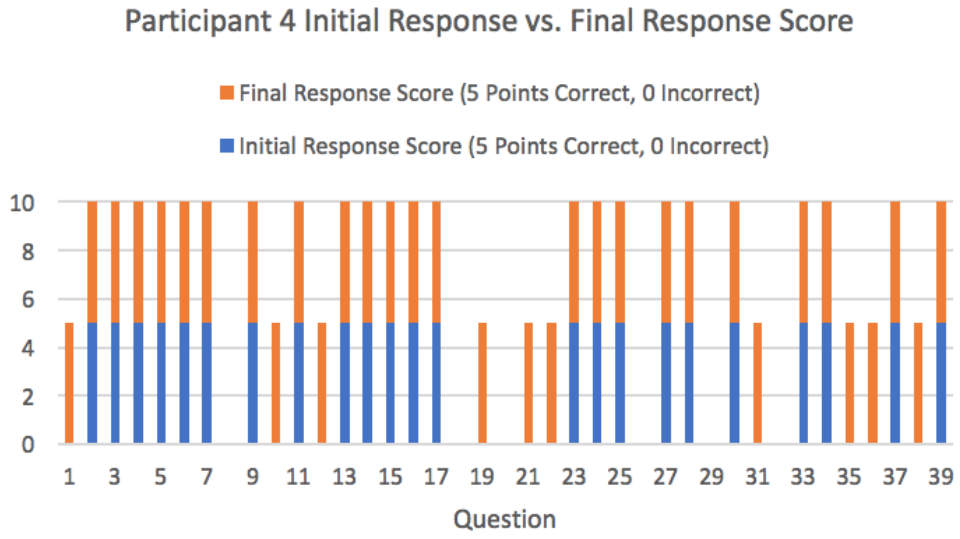

Figure 6. The table displays Participant Four's responses. Incorrect answers are represented by a blank cell.

Participant Five

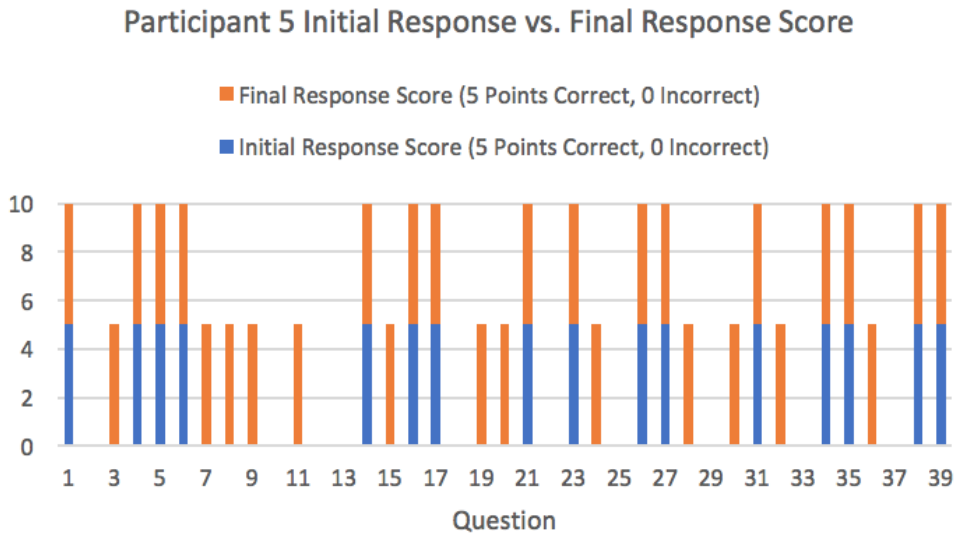

Figure 7. The table displays Participant Five's responses. Incorrect answers are represented by a blank cell.

Participant Six

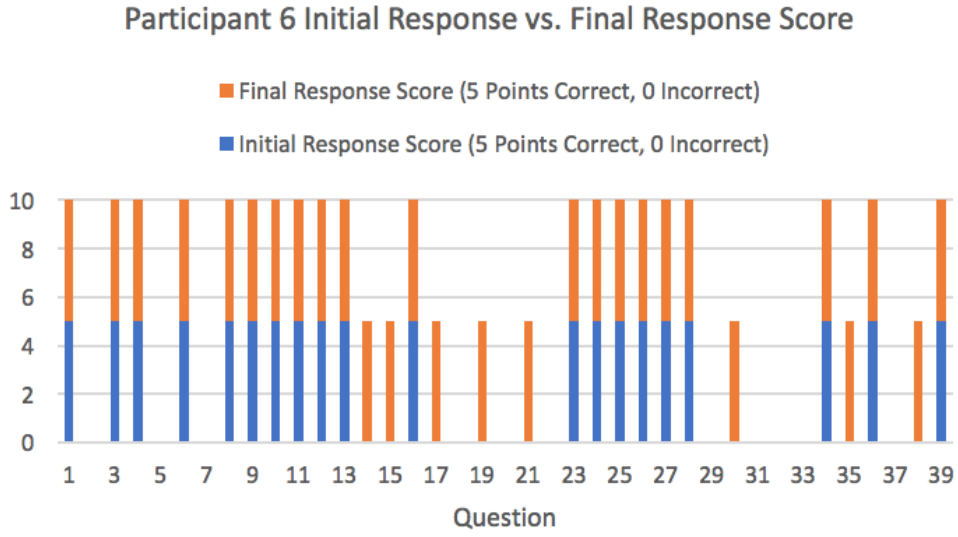

Figure 8. The table displays Participant Six's responses. Incorrect answers are represented by a blank cell.

Kinesthetic Approach Group

Participant Seven

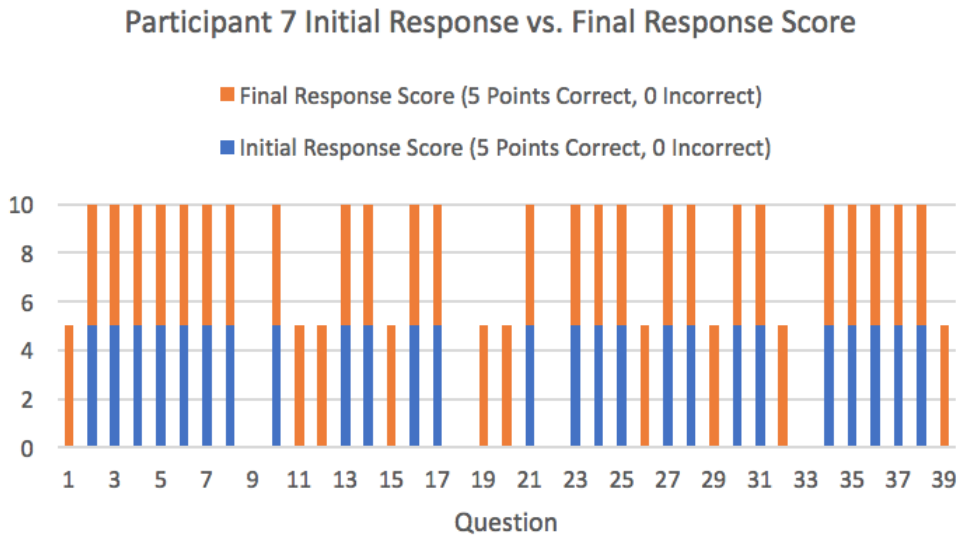

Figure 9. The table displays Participant Seven's responses. Incorrect answers are represented by a blank cell.

Participant Eight

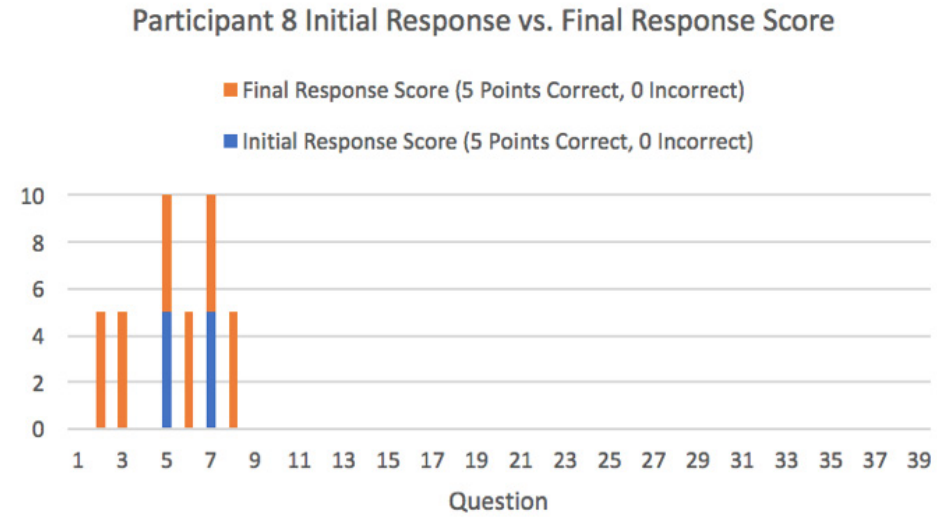

Figure 10. The table displays Participant Eight's responses. Incorrect answers are represented by a blank cell.

Participant Nine

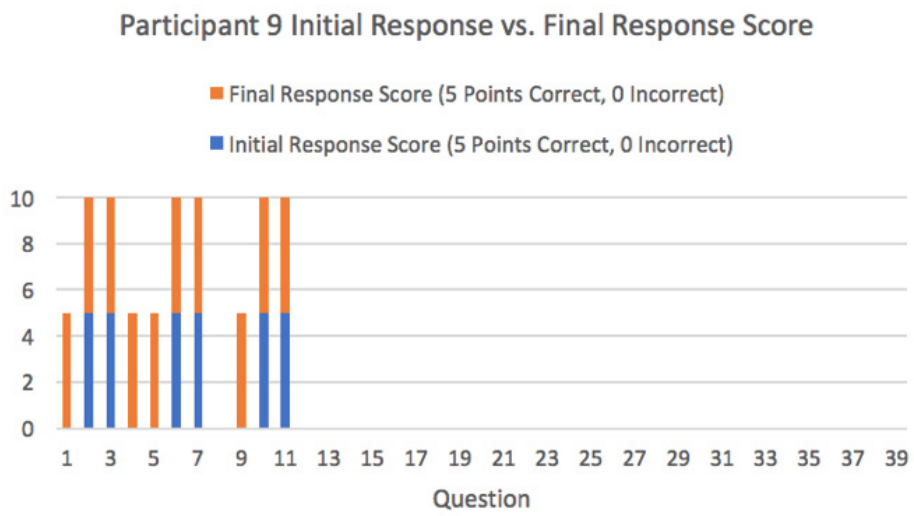

Figure 11. The table displays Participant Nine's responses. Incorrect answers are represented by a blank cell.

Statistical Analysis of Improvement

Within the control group, Participant One improved by 7.69%, Participant Two by 10.26%, and Participant Three by 0% (M=5.98, SD=5.34). Within the visual approach group, Participant Four improved by 25.64%, Participant Five by 33.33%, and Participant Six by 20.51% (M=26.49, SD=6.45). Within the kinesthetic approach group, Participant Seven improved by 25.64%, Participant Eight by 44.44%, and Participant Nine by 33.33% (M=34.47, SD=9.45). When compared to the control group, the visual group displayed a P-value of 0.006621903 and the kinesthetic group displayed a P-value of 0.005227422. Neither P-value exceeded the Alpha value 0.05, concluding little statistical evidence is prevalent to support the null hypothesis, therefore rejecting the null hypothesis.

Analysis

It is concluded that the most effective teaching technique in this study is the kinesthetic approach to teaching. Surpassing the visual approach by 13.96%, the kinesthetic approach proved effective in improving, on average, each child's score by 34.47%. Meaning, each of the three participants in this category answered over one-third more questions correctly when they were asked the questions for a second time after observing the lesson in the kinesthetic approach. While the visual approach to teaching proved less beneficial, the scores of individuals in this category still surpassed the scores of participants in the control group by 20.51%. The visual approach proved successful in improving the participants' understanding of the questions by 26.49%, meaning each of the three participants in this category answered over one-fourth more questions correctly when they were asked the questions for a second time after observing the lesson in the visual approach. While the participants in the control group did not receive teaching, it can still be seen that, on average, the three participants' scores improved by 5.98% between the time they were first asked the question and when they were asked each question a second time. One possible explanation to explain such participants' improvement when receiving no additional teaching involves the idea that participants could have guessed the first time they answered the question but then truly attempted to answer the question when asked a second time. Another possible explanation surrounds the fact that the child could have misunderstood the question when asked initially but better understood

the second time it was presented. Regardless, the improvement within the control group can be categorized as null when interpreting the other categories' results.

Limitations

Guessing appeared to be a common theme throughout the study. When the participants were presented with more challenging questions, they were likely to guess. Because each question had five answer choices, however, it was unlikely that occasional guessing could have had any significant effect on the data. Age could also be considered a confounding variable as the age range of the participants spanned eleven years; some of the older participants may have simply been more susceptible to learning the different concepts presented.

Conclusion

When evaluating the effectiveness of different teaching techniques on improving visual-spatial pattern recognition in children ages six to seventeen with Down syndrome, it can be concluded that a kinesthetic approach to teaching is more effective than a visual or non-informative method of teaching. Ultimately outshining the visual approach to teaching by 13.96%, the kinesthetic approach was found to improve, on average, each child's score by 34.47%. The visual approach did indeed prove to be more effective than a non-informative technique, however, as the scores of children in the visual teaching category surpassed the control group participants' scores by 20.51%.

Future Implications

For educational professionals, it is crucial to understand the most effective ways to teach a child, in order for progression to be made. The ability to measure the extent to which a child with Down syndrome can visualize different patterns and theoretical movements and their ability to improve such understandings through teaching sessions offered insight into which teaching method is most effective for such children. A major gap exists surrounding the best ways to teach children with Down syndrome and the knowledge that a kinesthetic approach to teaching is the most effective form creates a step in the direction of revising an education system that often fails to sufficiently educate its children with special needs. The incorporation of a kinesthetic approach to teaching into special needs classrooms will assist in making the education system more competent and impactful.

Acknowledgments

I would like to thank my advisor Lisa Mills for helping me with this Project.

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