Learning Links: Reflex Inhibition and Literacy Skills Enhanced for Under Achieving Elementary Students

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Abstract

One's ability to see, touch, feel, hear, move, and control ourselves in relationship to our environment has a definite impact on academic learning. Students with neuro-developmental delays may have difficulty beginning and completing tasks, staying in their seat, focusing and attending during instruction, and meeting the motor demands associated with reading and writing. Contrary to sedentary reading sessions, physical activity has been shown to improve a child's cognitive function and academic outcomes with no detrimental effects to learning when limited time is taken away from content instruction. Movement programs designed to promote reflex inhibition are linked to the neurological development necessary to enable students to be successful learners. Utilizing movement-based interventions to address primitive reflexes has been shown to improve academic performance. The purpose of this article is to describe the implementation of a motor lab program, entitled Learning Links (LL), based on the theoretical underpinnings of neurological development that may impact academic performance in children. Following a twelve week LL intervention consisting of K through 2nd grades, 90% of the participants demonstrated improvement with reflex inhibition and sensory motor skills. These improvements resulted in higher academic achievement and improved attentiveness in the classrooms.

1. Introduction

For academic success, students must exhibit physical abilities that include being able to sit still, pay attention, use a writing instrument, and control a series of eye movements [2]. Thus, students' ability to see, touch, feel, hear, move, and control themselves in relationship to their school environment has a definite impact on academic learning [6]. Understanding sensory and motor components of developmental readiness and their relationship to learning may help teachers, parents, and administrators recognize factors that may be hindering success in the classroom. For example, students with sensory motor deficits may have difficulty beginning and completing tasks, staying in their seat, focusing and attending during instruction, and meeting the motor demands associated with reading and writing.

The No Child Left Behind legislation has led to budget cuts and increased pressure for schools to increase standardized test scores [1]. There is pressure on students to do well, and teachers and administrators to adequately prepare students. For example, if students collectively perform poorly on state tests, teachers may be the ones held responsible. With the hope to improve reading scores, some schools throughout the country are opting for more "silent reading time" or uninterupted reading blocks of time in lieu of recess or physical education.

Contrary to sedentary reading sessions, physical activity has been shown to improve a child's cognitive function and academic outcomes with no detrimental effects to learning when limited time is taken away from content instruction [7]. Tomporowski, Miller, and Naglieri [8] found that exercise can be an important method of enhancing aspects of mental functioning central to cognitive development. Movement programs designed to promote reflex integration are linked to the neurological development necessary to enable students to be successful learners [4].

The purpose of this article is to describe the implementation and results of a motor lab program, entitled *Learning Links* (LL). LL is based on the theoretical underpinnings of neurological development that may impact academic performance in children. The first part of the article presents an overview of the effects of early motor development of children with respect to reflex pattern formation, which, if not appropriately active, may result in challenges for learning. The second part of the article describes the LL program as an intervention to promote reflex inhibition and motor development in identified students who were considered at risk for academic failure. Part three of the article shows how a pilot study was designed and implemented with students who were perceived to benefit from LL. The article concludes by sharing results of the reflex and reading scores of those students who were selected as participants in the initial LL pilot project, along with teacher and student satisfaction data.

2. Neurological development and links to learning

"Reflex" means action without thought. A reflex is an automatic and innate response to a stimulus. There are many types of reflexes. Blinking is a simple reflex. Other reflexes consist of more complex patterns of unconsciously coordinated muscular actions that form the basis of instinctive behavior. While some reflexes remain active throughout our lives, others such as primitive reflexes are developmental. These primitive reflexes appear in the womb or during the first years of life, and are then later integrated into mature movement patterns and skills. When primitive reflexes remain inappropriately active in a school aged child, motor and/or academic skills may suffer. For example, the child may utilize compensatory or faulty movement patterns to build increasingly complex skills that may interfere with appropriate neurological development and success.

Children develop continuously. Reflex and motor testing may provide information about the maturity level of the child's central nervous system. Prevalent primitive reflex patterns that should be well integrated in the school aged child include: Asymmetrical Tonic Neck Reflex (ATNR); Symetrical Tonic Neck Reflex (STNR); Tonic Labyrinthine Reflex, prone extension (TLR-P); and, Labyrinthine Reflex, supine (TLR-S). See Table 1 for a list of complications related to academic learning that have been found to be related to retention of the ATNR, STNR, TLR-P, and TLR-S.

Table 1. Academic implications related to retention of ATNR, STNR and TLR-P & S

ATNR Complications	STNR Complications	TLR-P & S Complications
• Poor handwriting • Focus and balance difficulties • Tight pencil grip • Confused hand dominance • Poor eye tracking • Dyslexia characteristics • Poor listening, handwriting, and spelling • Difficulties with math • Poor sense of direction • Poor fluency with written expression	• Poor eye hand coordination • Difficulty with reading and writing • Difficulty with copying • Poor balance • "clumsy" • Messy eater • Slow at copying from the board • Poor ball skills • "W" sitting • Headaches from muscle tension in neck • Difficulty staying on task/ "Fidgety" • Vision disorders	• Slouched posture • Low muscle tone • Poor balance and coordination skills • Motion sickness • Avoidance of physical activities • Visual perceptual difficulties • Tendency to walk forward on toes • Weak ball skills • Poor articulation • Diffuculty with distance, depth, space, and speed • Fatigues easily

Movement programs designed to promote reflex integration are linked to neurological development. Using movement-based interventions to address primitive reflexes has been shown to improve academic performance [4].

3. *The Learning Links* motor lab program

3.1. What is *Learning Links?*

Learning Links (LL) is a unique and innovative program developed through collaboration among school-based Occupational and Physical Therapists and an Adapted Physical Education Professor at a local college. LL was implemented as a pilot study at an elementary school in the spring of 2013. LL is designed to use movement-based interventions to inhibit retained reflexes and promote sensorimotor development in school aged students. Improved primitive reflex inhibition has been found to have a positive impact on the development of foundational skills and abilities that play a critical role in learning. These include attention and concentration, memory, behavior, strength and endurance, posture and body awareness, motor planning, balance, laterality and directionality, perceptual and visual motor skills, midline crossing, and gross and fine motor skills. The LL program is designed to target struggling learners (ages 4-8) who demonstrate retained primitive and delayed postural reflex patterns. Rationale for including students in Kindergarten, 1st, and 2nd grade (kindergarten was used as the pilot) is based on current research that supports interventions are most effective at an early age. Young [9] explains that half of a person's intelligence potential is developed by age four. She further describes that early childhood interventions can have a lasting effect on intellectual capacity, personality, and social behavior.

Learning Links includes movement-based interventions designed to enhance literacy skills for students who are considered at risk for academic failure. Specific goals for LL include:

- Goal 1 : Target young students considered "At Risk" for academic failure based on district test

scores and identified retained primitive and delayed postural reflex integration
- Goal 2: Provide a Tier 2 intervention supported by Response to Intervention (RTI) through motor lab activities that will remediate learning problems due to possible neurological developmental delays

3.2. Pilot Study Implementation Plan

Six kindergarten classroom teachers were asked to select general education students from their classrooms based on poor academic performance scores and retention of two or more primitive reflexes. Parent/guardian consent forms were sent home to all identified students prior to reflex screening. Only students with returned permission slips were eligible to participate in the LL program.

Data was collected through teacher checklists, reflex screening, and work samples. Reflex screening and motor lab implementation took place in a designated area, with a ratio of two therapists to one student. The LL motor lab intervention program was scheduled five times weekly for twenty minutes each day over the course of twelve weeks. See Table 2 for a description of the LL timeline.

Table 2. *Learning Links* timeline

Date	Activity
January/ August	Planning meetings for all aspects of program development.
January/ August	Meet with school district to discuss *Learning Links* motor lab program.
Late January/ August	Submit Research Application to participating school district and/or college/university.
February/ September	Professional development meetings featuring a power point presentation and handouts to participating school administrators, reading teachers, physical education teachers, and Kindergarten faculty
February/ September	Elementary School Principals determine who will be chosen for the *Learning Links* program based on current academic achievement (i.e. bottom 25%, lowest performers in each class that will be participating.)
February/ September	Provide *Learning Links* Parent/Guardian Permission forms to campus liaison to be distributed to parents/guardians of identified students for motor lab participation.
February/ September	Provide Behavioral Observation Checklists to campus liaisons for distribution to teachers of participating students.
March/ October	Further screening for inclusion into the *Learning Links* program regarding reflexes (ATNR, STNR, TLR-P, and TLR-S). Send home letters to parents to notify them as to whether their child was included into the program or not based on the inclusion criteria.
March/ October	Start *Learning Links* program. Program begins with movement sessions conducted 5 days/week for 20 minutes each day. Program runs for 12 weeks. Conduct additional screenings for ocular motor control, balance, and visual motor integration.
Late May/ December	Begin Post testing assessment process.
Late May/ December	End of *Learning Links* program celebration during motor lab group time. Present each participant with a *Learning Links* Certificate.

4. Description of program implementation

4.1. Professional development presentation

Approval for a motor lab program was obtained by school administrators and personnel. A professional development presentation was conducted to describe the purpose of the study and goals of the *Learning Links* motor lab program. Attendees included school administrators, Physical Education Teachers, Reading Specialist, Special Education and General Education teachers.

4.2. Collection of at-risk student referrals from teachers

At the first spring semester meeting of the year, Kindergarten teachers were informed about the motor lab program and how to select students for the study. Specifically, teachers were first asked to identify students for the program who were observed to have traits of an immature reflex, vestibular, tactile or proprioceptive system. These behavior traits may include students who have difficulty riding a bike, catching a ball, grasping their pencil, and/or keeping their place on a page while reading. Second, to identify students with an immature vestibular system, teachers were asked to select students who may prefer to move about the room while reading, and/or may be described as "hyperactive." Third, to identify students with a possible immature tactile system, teachers were asked to select students who may frequently seek oral stimulation, touch everything or reacts adversely to touch, and/or have difficulty with fine motor skills. Lastly, to identify students with a possible

immature proprioceptive system, teachers were asked to select students who exhibited behaviors such as using furniture to hold themselves up or kicking their foot to keep their brain alert in order to stay on task. Each homeroom teacher was provided one week to compile a list of their most "at risk" students based on these observable behaviors.

4.3. Permission slips

Parent/guardian permission forms were sent home to all identified students. Only students with returned permission slips were allowed to participate in the motor lab program. Parents were informed that this study was approved by an institutional review board to be performed in accordance with ethical standards. Informed consent was obtained from all individual participants included in the study.

4.4. Screen the at-risk students

Reflex screening, pre-writing samples, teacher questionnaire, and Dynamic Indicators of Basic Early Literacy Skills (DIBELS) scores were collected for all participants.

4.4.1. Reflex testing. ATNR, STNR, and TLR reflexes based on procedures by *Ready Bodies Learning Minds* [6] were used. These movements included 'Popcorn,' 'Superman,' 'Giraffe Stretch,' and 'Rocking Horse.' Participants were rated on a mild, moderate, severe scale.

In the Popcorn position, the student begins by lying flat on their back. He then brings his knees to his chest while wrapping his arms around his legs. He then lifts his head, with his eyes almost touching his knees. The student then attempts to maintain this position without rolling over to the side or lowering his head, arms, or legs.

In the Superman position, the student lays flat on her stomach. Have her then raise her chin off the floor, then extend her arms overhead close to her ears while lifting her legs off the floor at the same time. Using a tight streamline position, only the midriff should be touching the floor. The name Superman is given as it looks like the student is flying through the air. The student then attempts to maintain this position without their head, arms, or legs making contact with the floor for a period of time.

In the Giraffe Stretch, the student begins by being on his hands and knees. He then lifts his head so that his neck is extended. With his chin in the air and the back level, he then leans forward without moving his hands. His shoulders should then move forward past the position of his hands on the floor.

Finally, in the Rocking Horse position, have the student go on her hands and knees. She then brings her head down so that the back of her head is level with the back of her body. She then gently turns her head to the right or left, with the chin approaching the shoulder. The student then holds this for several seconds. She then slowly turns her head to the other shoulder and rocks again [5].

4.4.2. Handwriting samples and copy design. On a sheet of paper, students were asked to write their first name on a line using a pencil. Below this line students were asked to copy four developmentally appropriate shapes.

4.4.3. Teacher questionnaire. Teachers were asked to complete a Behavior Checklist for each student participating in the *Learning Links* program. Describe/Insert Teacher Questionnaire. Teachers were asked to indicate their perceived level of impairment (Severe-exhibiting the behavior 75-100% of the time; Significant-exhibiting the behavior 50-75% of the time; Moderate-exhibiting the behavior 25-50% of the time; Slight-exhibiting the behavior 0-25% of the time; or No Impairment) for their students who had been selected for participation in the motor lab group. The following 17 areas were surveyed: uncooperative, lack of self-confidence, limited eye contact, difficulty following instructions, distractible, easily frustrated, withdrawn, inattentive, cannot remain still, below grade reading skills, below grade math skills, heavy oral stimulation (chewer), disorganized, inability to pay attention, lack of peer interaction, poor muscle tone/energy, and decreased awareness of personal space.

4.5. DIBELS testing

These measures are used to assess the following: phonological awareness, alphabetic principle, fluency with connected text, vocabulary, and comprehension and are designed for children in kindergarten through sixth grade. They were developed in the 1970s-80s by Deno and colleagues through the Institute of Research and Learning Disabilities. The DIBELS were developed based on procedure for Curriculum-Based Measurements, and since their development have been through ongoing research to document their reliability and validity [3]. These measures have been found to be predictive of later reading proficiency and are linked to one another. The DIBELS scores are used to determine student progress in early literacy development.

5. Implementation of 12 week motor lab sessions

5.1. *Learning Links* motor lab

A classroom was designated as the *Learning Links* motor lab. For safety and staffing reasons, there were four groups of 6 students who attended the motor lab daily on twenty minute rotations. Selected students were sent home with a consent form describing the *Learning Links* program.

An occupational therapist (OT) was assigned to oversee the motor lab with volunteers that consisted of local university OT and Adapted Physical Education/Physical Education (APE/PE) students. One OT was chosen to run the groups to ensure consistency among the lessons. A typical motor lab session included the following: hopscotch in, followed by a gross motor movement (i.e. bear walk, crab walk, bunny hop) to a designated tape square area. Once at their carpet square, the therapist led the students through group exercises with emphasis on primitive reflex inhibition, postural stability, midline crossing, bilateral integration, and ocular motor control.

Following the reflex exercises, students were assigned to their first station. The therapist demonstrated to the students the incorrect and then the correct way to perform each station. The therapist also emphasized control and quality of the movements. Six stations were set up to work on the following areas: vision, balance/vestibular system, proprioception, spatial awareness, eye-hand, eye-foot coordination, crossing midline, and fine motor coordination and/or visual motor integration. Students participated individually or in pairs at each station for duration of one to two minutes before rotating to the next station. After completing each station, students returned to their carpet square and were individually chosen for an exit activity (i.e. basketball shot followed by hopscotch).

Every six days (this Western New York school was on a 6-day schedule), the motor lab stations were changed. The change was based on the majority of students mastering the skill or the station was modified in order to further refine the skill. On the final day of the twelve week program, students completed the reflex screening in addition to completing a post program writing sample. Classroom teachers were provided with the post Teacher Questionnaire (Behavioral Checklist) and asked to complete it within a weeks' time. DIBELS post test scores were collected one month later, as this coincided with the school testing procedures.

5.1.1. Post-testing. Post testing assessments included retesting the students' reflexes; collecting the DIBELS standardized scores, and teacher questionnaires.

5.1.2. Report cards. In order to communicate progress with the parents, progress reports were sent home with home exercise program information as needed. For example, if a student continued to show signs of a retained reflex, exercises to promote reflex inhibition and sensory motor development were sent home with a description on how to perform each of them.

5.1.3. Certificates. On the final day of the LL program, students rotated through familiar and 'favorite' stations which they had voted on during the previous week. Students were then provided with certificates of completion and received recognition for their hard work and participation.

6. Learning Links Results

6.1. Reflex Results

6.1.1. Overall Reflex Improvement Results. As previously mentioned, students were screened both pre and post on the following reflexes: ATNR, STNR, TLR-P, TLR-S. Of the 24 participants in the program (no control group was utilized as per requested by the school to include as many students in the program as possible), students showed an overall pre-post improvement of at least 91.66%. More specifically, the following table displays the percent improvement for each of the reflexes tested.

Table 3. Learning Links Overall Reflex Improvement Results

Reflex	Number of Students	% Improvement
ATNR	22/24	91.66%
STNR	24/24	100%
TLR-P	24/24	100%
TLR-S	22/24	91.66%

5.1.4. Individual Reflex Results. Individual reflex scores are categorized using the following grades: severe, moderate, mild, and pass. In order to qualify for the program, students must have scored either a severe or moderate on the majority of their individual reflexes.

The following tables provide a breakdown on performance results of the 4 reflexes tested. Data provided shows overall improvement on all reflexes tested. There were also at least 2-3 therapists testing each student in order to ensure reliability of reflex testing results.

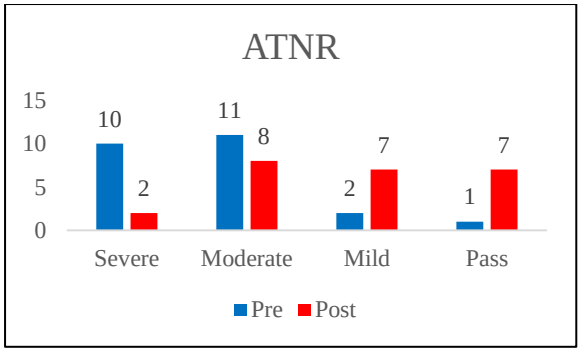

Figure 1. ATNR Results

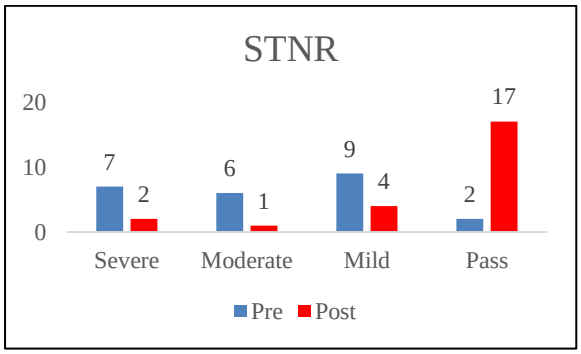

Figure 2. STNR Results

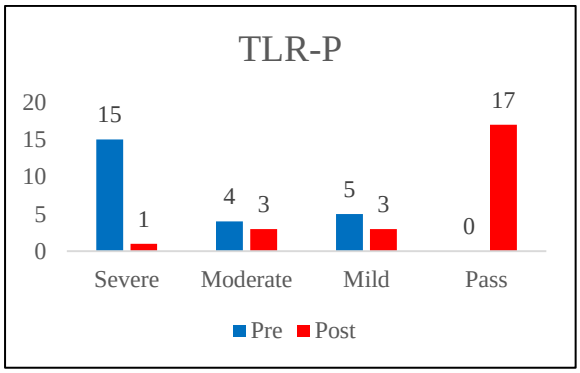

Figure 3. TLR-P Results

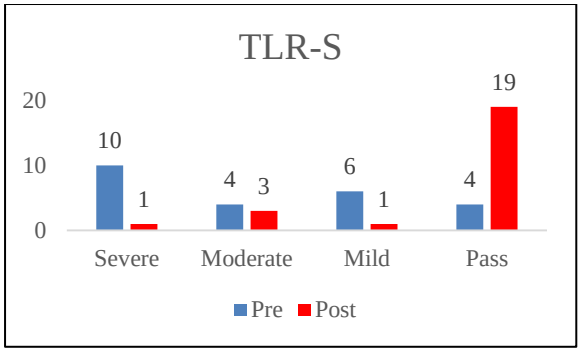

Figure 4. TLR-S Results

5.1. Teacher Classroom Behavior Questionnaire Results

Teachers were provided a student behavior questionnaire prior to the start as well as at the completion of the LL program. Greatest results were seen in the areas of "fidgety," where 62.5% of the students were classified as this at the beginning of the program and only 8.3% at the completion. "Below Grade Math Skills" also saw a decrease from 45.8% to 0%, "Has Difficulty Staying in the Classroom Chair" from 54.2% to 4.2%. Of the 18 areas questioned, only one showed negative results. "Confuses Right and Left Side of the Body" went from 12.5% to 16.6% of students.

5.2. Student Feedback

Following the implementation of the LL program, students were asked a series of questions on whether or not they enjoyed the program. This was done to gain feedback from a student perspective in order to make improvements for the following semester when it would be implemented again. When asked whether or not they "Would come back next year," all but two students said yes. Of the 22 students who responded yes, some comments collected included: "It's fun," "Like the people," and "Learn more games." The two students who said they would not come back next year elaborated on their reasoning behind that answer, "I'm going to be too big," and "Would rather stay in class."

Of the program participants, half of them liked working alone at their stations, while the other half enjoyed the partner games and activities. For program efficacy, the majority of individual stations were implemented at the beginning of the semester and partner stations near the end of the 12 week program.

Some of the stations that students enjoyed included: scooter board, trampoline, beanbag toss, and bouncing the ball. Some of the stations that they did not enjoy were: coloring, visual tracking, and egg filler. Of the stations listed, the ones they did not enjoy were the sedentary stations, whereas they enjoyed the more active stations.

5.3. Teacher Feedback

Overall, teachers seemed to be receptive towards the program. What aided in this process was the orientation session prior to the beginning of the semester where teachers were made aware of the basis of the program in addition to possible program benefits and outcomes.

Following the completion of the 12 week program, teachers were provided their teacher

questionnaire. On the bottom of the questionnaire was space to include comments and teachers were encouraged to be honest in order for program improvement the following semester.

Some teacher comments included that the LL staff were "prompt and quiet," "courteous and professional." The staff of the program understood that some teachers were hesitant of the pull-out program during the school day, therefore, attempted to answer any questions the teachers might have as well as ensure that by going classroom to classroom to pick up students that they would not disrupt the current lesson the teacher was instructing.

Another teacher believed students will "gain better motor skills & the ability to focus and remain seated throughout the day." Evidence of this accomplishment was seen through the results of the teacher checklist where students improved on "staying in the classroom chair," and "fidgety."

Teachers also felt that "students will succeed better academically due to participation in this program." In fact, we were made aware that following the implementation of this program, there were only four students considered "intensive" going from kindergarten to first grade. Typically the number of "intensive" students are over 20. Teachers and the principal attributed this result to the implementation of the Learning Links program and the 24 students that it benefited. Lastly, we were pleased to read that teachers, "Hope the program continues next year and perhaps even accommodate a few more students."

Although students were pulled a total of 150 minutes from class per week over a 12-week period, teachers were still pleased with the results of the program. They felt that with the program being implemented in the morning, their students were ready to learn and focus for the remainder of the school day.

6. Conclusions

In just twelve weeks participating in LL, 91.6% of students demonstrated improvements with inhibiting retained ATNR and TLR-S reflexes. Post LL program screenings yielded results indicating that 100% of students demonstrated appropriate passing criteria with STNR and TLR-P reflexes. In addition, teachers reported better academic achievement and attentiveness in the classrooms. Teachers were amazed at how beneficial the program was and were eager for their new kindergarten students to attend LL during the upcoming school year. Teachers also understood the importance of students attending the LL program in the morning, as the benefits were seen throughout the school day.

For Occupational Therapists, Physical Education teachers, or other professionals working with this age group, it is important to understand that there are not only programs, but individual activities that can be incorporated into our curriculums to help inhibit retained reflexes that should already be integrated by the time a child is enrolled in school. As stated above, retained reflexes can affect anything from academic performance, attentiveness, behavior, to even getting a drink at the water fountain.

7. Future Research

The research team is currently in the process of preparing to implement the LL program for a Charter School in Western New York. Participants will include students in grades Kindergarten, first and second, with control groups to match students at each of the grade levels. Additional future research will include larger sample sizes in order to demonstrate greater program efficacy.

8. References

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