Journal of Neurology & Experimental Neuroscience

https://doi.org/10.17756/jnen.2023-103

Research Article

Open Access

Primitive Reflex Integration and Reading Achievement in the Classroom

Tessa M Grigg[1*], Ian Culpan[2], and Wendy Fox-Turnbull[3]

[1]*College of Education Health and Human Development, University of Canterbury*

[2]*College of Education Health and Human Development, University of Canterbury*

[3]*Wendy Fox-Turnbull, Division of Education, Waikato University*

***Correspondence to:**

Tessa M Grigg
College of Education Health and Human Development, University of Canterbury, Christchurch, New Zealand
Tel: +64 274 774 825
E-mail: tessa.grigg@canterbury.ac.nz

Received: October 12, 2022
Accepted: February 24, 2023
Published: February 26, 2023

Citation: Grigg TM, Culpan I, Turnbull WF. 2023. Primitive Reflex Integration and Reading Achievement in the Classroom. *J Neurol Exp Neurosci* 9(1): 18-26.

Published by United Scientific Group

Abstract

Objective: Children's primitive reflexes typically integrate within the first twelve months of life. If this process is interrupted through maternal or environmental stress, developmental immaturities can occur, leading to educational challenges for children. While other reflex integration exercises have been studied within group settings, the set of rhythmic based movements used in this research has not. As rhythm is a valuable element in a child's development, this aspect of the movements was of interest. The research was conducted post-2011 Christchurch earthquakes, a devastating event for the city. The participants were in utero or infants when the quake struck.

Method: This article reports on a reflex integration intervention used in six New Zealand classrooms. The research lasted ten months, and 98 six to eight-year-olds completed four movements for five minutes daily, three-five times per week. This mixed-methods research evaluated reflex retention scores, reading, and teachers' perceptions of achievements.

Results: The conclusion showed post-intervention that the intervention group's reflex profiles were lower than the control's by a statistically significant ($p = 0.018$) margin. Reading scores increased significantly ($p = 0.002$) when the movements were used four or more times per week. It was also noted that the reflex scores for this group of children were higher than expected and higher than that of another group of New Zealand children.

Conclusion: Decreased retained primitive reflexes, improved reading scores and teacher comments showing general class improvements suggest that there is benefit in using movement-based reflex integration activities within a classroom setting.

Keywords

Children, Learning and behavioural intervention, Mixed-methods, Retained primitive reflexes, Primitive reflexes, Learning delays

Introduction

COVID-19 has changed the environment into which children are being born. Families have experienced additional stress through the pandemic [1], with research showing that relationships, mental health, and stress levels have been impacted. It is also understood that disasters create additional strain on mental health [2], and continued restrictions can extend that stress. An American study [3] has found that infants born after the beginning of the pandemic show significant reductions in skill development and cognitive function compared to infants born during or before 2019. The researchers link these findings to heightened

levels of maternal stress and restrictions that have limited experiences to support healthy neurodevelopment. They did not connect the possibility that this lack of typical neurodevelopment could also be related to the retention of primitive reflexes. Maternal and environmental stress are considered the main factors in interrupting the typical development of these life-supporting reflexes. When primitive reflexes are retained beyond their useful timeframe in a child's development, there are implications for carers and teachers. This article highlights the issues associated with retained primitive reflexes and reports on preliminary research that used a reflex integration program in schools.

Primitive reflex retention has been identified as an inhibitor of development [4-7]. While immaturities have been identified in social and emotional development when primitive reflexes are still present in school-aged children [8-10], this article focuses on classroom-based student reading achievement and its relationship to retained primitive reflexes.

Most children are born with a set of fully developed primitive reflexes, developed *in utero* [10]. These are used for the infant's initial survival and the journey down the birth canal, their first breath, first drink, and early movements. As the child matures, primitive reflexes are integrated. The reflex reaction or action is replaced by cognition (the child chooses to drink, or stretches out the arms to indicate they would like to be picked up) or postural reflexes (they can subconsciously prevent the loss of balance on an uneven surface). A typically developing child will use their primitive reflexes before the integration process occurs. However, this integration process is interrupted for some children, and maturation is delayed. Is it possible to address the retention of primitive reflexes and thus improve achievement outcomes for children?

The reflex integration programme used in this research was Rhythmic Movement Training (RMT). Through observation of typically and atypically developing infants, a Swedish occupational therapist, Kirste Lunde, developed a set of rhythmic movements designed to aid children's integration of their primitive reflexes [11]. Blomberg [12] and Dempsey [11] developed the programme and training further. Grigg's [13] qualitative research investigated the home-based use of RMT through parent perceptions. Fourteen parents were interviewed, and their perceptions included views that RMT was a low-cost intervention that was easy to use within their family routine. However, this article focuses on school-based achievement outcomes for children when they use RMT for five months.

Literature Review

With primitive reflexes in focus, this literature review includes Hughlings-Jackson's early theories, Thelen's movement theories, and research relating to reflex integration programmes giving context to the current research. The primitive reflex discussion began in the 1850's with Hughlings-Jackson's reports of a central nervous system evolutionary-based process that he believed was pivotal in a child's development [8]. As a doctor, he was interested in neurology and concluded that some behaviour or neurological-based conditions, such as seizures, were linked to retained primitive reflexes [14]. His theories were developed further by researchers such as Furfey, Bonham and Sargent [15], who used primitive reflexes in medical settings to determine the mental ability of an infant. Capute [16, 17] also used primitive reflexes to aid in diagnosing neurological or developmental delay and subsequent intervention recommendations [18, 19].

In the 1970's, research linking retained primitive reflexes and learning challenges began to expand. Rider's [20] research established a link between retained reflexes and learning delays, particularly for boys. Goddard's [5] book, *A Teacher's Window into the Child's Mind,* detailed the influence of primitive reflexes on children's learning. She developed a series of movements that reportedly enabled the body to progress the maturation of the reflexes. Irish researchers [6, 21, 22] found links between the Asymmetric Tonic Neck Reflex (ATNR) and lowered academic outcomes.

Thelen's research in the 1980's emphasised the movements infants make and the association of these movements with brain development [23]. She believed that there were multiple movement pathways and that all movement was helpful, particularly children's rhythmic movements made as infants. Thelen argued that early movement prepares children for future academic learning [24] and highlighted that children prefer to move regularly. Regular opportunities to move align children's movement strategies with distributed practice theory [25], where small amounts of regular practice (movement) have a greater benefit than long, irregular practices. Leisman et al. [26] also emphasise the importance of movement and cognition and their interdependence on each other.

Research on primitive reflex retention and the association to both achievement and behavioural outcomes has been the focus of several researchers [4, 6, 8-10, 22, 27-30]. McPhillips and Sheeny [6] found that a retained ATNR was more prevalent in children with lower academic skills. Konicarova and Bob [10] found that children with an Attention Deficit Hyperactivity Disorder diagnosis had higher than expected levels of retained Moro and Spinal Galant reflexes [6]. Reading delays and links to motor development have been the subject of Irish research [6]. Taken from a sample of 409 children, within 41 children in the bottom reader group, they found that verbal IQ and SES were predictors of ATNR persistence and reading challenges. Matuszkiewicz and Galkowski [7] found that in children with language delays, there were significantly higher levels of reflex retention for all reflexes tested (Moro, ATNR, tonic labyrinthine reflex (TLR), symmetric tonic neck reflex (STNR), and the Spinal Galant reflex).

Peer-reviewed research relating to the efficacy of RMT was not found before the undertaking of this research. However, research completed by researchers from the United Kingdom [21, 31, 32] found that using reflex integration programmes such as the Primary Movement Programme [33] and the Institute for Neuro-Physiological Psychology (INPP) programme [31] showed gains in the reading abilities of children in the intervention groups. Both programmes contain a series of movements that replicate infant movements. However, neither of these programmes incorporates rhythm as it is used in the RMT programme.

Materials and Methods

Research design and methods

Design

A mixed methods research design explored the phenomenon of retained primitive reflexes and student achievement. A classroom-based intervention was assessed after five months using a convergent, longitudinal panel design where data was gathered sequentially and concurrently. The mix of qualitative and quantitative data was designed to capture the complexities of retained reflexes and the outcomes of the intervention. A hermeneutic approach found a range of themes associated with the qualitative data. The overriding research question; *What influences does the use of RMT have in a classroom?* was supplemented with the following question; *What influence does participation in an RMT programme have on student achievement in reading?* Participants included; 98 children aged six-eight years (divided into evenly matched control (n = 46) and intervention groups (n = 52) based on reflex scores and reading scores), seven teachers each with over five years of teaching experience, and 26 parents. Previous studies of children's retained reflexes and reading abilities focused on low socio-economic status (SES) schools [22, 27, 30, 34]. However, the children in this research were students at three SES level schools, high (n = 22, 25-child class with one teacher), middle (n = 50, 69-child class with three teachers) and low (n = 26, 49-child class with two teachers), as rated by the New Zealand's household income statistics [35]. The spread of children's SES status in the research did not exactly match the New Zealand population. Based on the number of children in the research and the percentage of the total population in each group, the low SES (NZ-wide n = 24.7) matched, but the middle (NZ-wide n = 34.8) and high (NZ-wide n = 38.3) did not. The current research had more middle-income families and fewer high-income families when compared to the general population. However, all SES groups were represented. Selecting schools from different SES levels was intended to question findings by McPhillips et al. [22] that reflex retention was more pronounced in low SES populations.

The design of this research differed from others in the area. Previous studies using reflex integration programmes [22, 30] used single classrooms as control and intervention groups. The teacher effect was raised as a reason for improved reading scores in the McPhillips and Brown research. In this research, the children in the three schools were all in one class group. Each group was divided evenly into either control or intervention, matched on gender and levels of reflex integration. This removed the possibility of the teacher's effectiveness influencing the results. The University of Canterbury's Education Research Human Ethics Committee granted ethics approval. The research involved two phases; Phase 1 lasted for five months, and the groups were divided (the control carrying on with the classroom routine for five minutes and the intervention group completing five minutes of the intervention). In Phase 2, five and a half months, all children completed the movements. The difficulties associated with this design are highlighted in the discussion section.

Testing

A range of tests were completed for the research to reflect possible issues associated with retained primitive reflexes. The researcher was mindful that adding additional tests to a school environment where extensive testing was already being undertaken could lead to over-testing children [36]. Reading tests were used based on New Zealand National Standards where schools provide results from a range of non-standardised and standardised tests to the NZ government. Overall Teacher Judgement and teacher moderation were key factors in the testing process [37]. All schools used PM Benchmark Running Records and Overall Teacher Judgement While the tests are not standardised, they have been levelled in Australia. The tests placed children at a reading level. The reading levels do not have a linear progression, with nine levels each for the first two years and four levels each for the next two years. To enable statistical modelling, the reading levels were allocated linear steps, four for each year level. Pre-intervention results in show that a statistically significant difference was not detected between the control and intervention group.

Written consent was gained from all participants, and children were tested for the presence of three reflexes: TLR, ATNR, and Spinal Galant [5]. The tests were selected based on ease and appropriateness with which children could be tested and their relatedness to the movements chosen for the children to complete. The TLR test required the child to bend the head forward slowly and then backwards with the hands remaining at the side of the body, with eyes open and eyes closed. The tester noticed additional movements in the body, feet and shoulders, and wobbling or disorientation (0 = no movement, 1 = slight adjustment, 2 = disturbed balance, 3 = near loss of balance, and 4 = loss of balance). The ATNR test required the child to hold the arms out in front at 90 degrees to the body, and with closed eyes, slowly turn the head from one side to the other (0 = no arm movement, 1 = slight arm movement, 2 = arms move 45 degrees towards face, 3 = arms move 60 degrees towards the face and 4 = arms rotated with face and/or loss of balance). The Spinal Galant test required the child to kneel, both knees and hands touching the floor and the back parallel to the floor. The tester showed the child a rounded ended pen, which was then run down either side of the spine: (0 = no movement, 1 = slight hip movement or back undulation of 15 degrees, 2 = hip movement or back undulation of 30 degrees, 3 = hip movement and back undulation of 45 degrees, and 4 = hip movement, undulation of 45 degrees and loss of balance). For all tests, the researcher demonstrated the movement and the child was asked to complete what they had observed. Children were tested at the beginning, midway (5 months), and conclusion of the research (10 months). All reflex tests were recorded and checked twice to ensure consistency.

Data analysis

Data analysis used R Statistical Software [38] to examine the variables. A linear mixed-effects model [39, 40] was used to statistically analyse data from multiple time points (beginning, mid-point, and conclusion) gathered from the reading and reflex testing. The dependent variables were the academ-

ic tests and reflex tests. The independent variables were time completing RMT (Intervention or Control) and the frequency of the movements (four or more times per week or less than four times per week), while the control variables were gender and SES.

Qualitative information from teachers was gathered throughout the research (observations and teacher comments were recorded as field notes in a research diary), and semi-structured 15 – 30-minute interviews were used towards the end of the research. Participants (parents and teachers) received the sample questions before the interview [41-43], although the questions were only used as a guide. The interviews were recorded, transcribed and coded (using NVivo 11 software) by the researcher. To ensure validity and reliability [42], teachers were provided with transcriptions of their interviews, and an experienced RMT practitioner (Dempsey) reviewed video of children's reflex tests. From the information gathered through NVivo coding, themes based on the comments were established and then refined. The results and findings were reported under three themes: RMT in the classroom, perceptions of student achievement and perceptions, and student behaviour. This article focuses on the perceptions of student achievement, in particular reading.

The intervention

Rhythmic Movement Training [11] has a total of 17 movements, and the four chosen for this research were based on ease of use in the classroom setting and the reflexes targeted. Movements targeting the cerebellum were used as it was reported that they could support attention and concentration in children [12]. For *bottom/hip rolling (*targeting the cerebellum and Moro and Spinal Galant reflexes, the child lies with their front on the ground and makes a small rolling movement of the hips from side to side. Head and feet are still. *Windscreen wipers* (targeting the cerebellum, ATNR, and Spinal Galant reflexes [12]) have the child lying on their back and moving the feet in and out. This is a whole leg movement. To complete the *Symmetrical Tonic Neck Reflex rock* (targeting STNR [12]), the child is in a kneeling position, and they rock backwards and forwards in the manner of a pre-crawling child. *Sliding on the back* (targeting the cerebellum and the Moro, TLR, and Spinal Galant reflexes [12]) requires the child to lie on their back with the knees bent and feet flat on the floor. The sliding movement goes from feet to head, and the head nods gently. When completing the movements correctly, a strong rhythmic element needs to be maintained. All classes were encouraged to complete the movements four to five times each week during the research.

The intervention group began the movements when reflex testing was completed. The research extended over a New Zealand school year; the intervention group began the movements in late February. The control group started the movements five months later, in mid-July. The intervention ended in early December. Approximately five minutes each day were allocated for the movements.

Findings and results – reflexes

The level of retained primitive reflexes of the participant children was higher than expected. Reported rates fall between 48% [28] and 89% of children having at least one primitive reflex still present at six years of age [44] with 25% having levels considered to impact typical development. In this research, 98% of the children had one or more primitive reflexes still present at the beginning of the research. Although this is not the focus of this article, many of the children in the research were in the womb, or infants when the Canterbury earthquakes struck. As maternal stress is reported to be a factor in primitive reflex retention [45], this was considered to be a factor in the high scores. Children's reflex profile scores were derived by adding the scores of their reflex tests, as described in the Methods and Design section. Figure 1 shows that in Group 1 (Intervention, n = 46), 71.74% (n = 33) of the children scored between 3 and 9 for their reflex profile and 28.26% (n = 13) scored between 0 and 2. Group 2 (Control, n = 52), 78.85% (n = 41) scored between 3 and 9 and 21.15% (n = 11) scored between 0 and 2.

The frequency of completion of the movements was noticed as a factor in the reduction of the primitive reflex scores. Children who generically completed the movements, four or more times a week showed a statistically significant reduction in primitive reflex scores ($p = 0.018$) (Table 1, 2, and 3). Table 1 compares the reflex scores of the Control and Intervention groups with the scores of children who used the movements four or more times each week or less than four times each week. While all scores were reduced over the research period, the greatest reduction was shown in the children using RMT four or more times each week. Their mean scores went from 4.37 to 1.31, whereas the children using the movements less than four times a week went from 3.99 to 2.50.

Table 2 shows that using a linear mixed-effect regression model, statistically significant differences were detected between the group of children using RMT four or more times each week ($p = 0.018$) when compared with children using RMT less than four times each week. Table 3 shows that overall there was not a statistically significant difference between the reflex profiles of the two groups.

Findings and results; socio-economic status and reflex profiles

The SES spread of the participants in the research groups was across all levels and was similar to the general population in New Zealand. An analysis of variance (ANOVA) test was calculated using the SES (decile) rating of each school and the

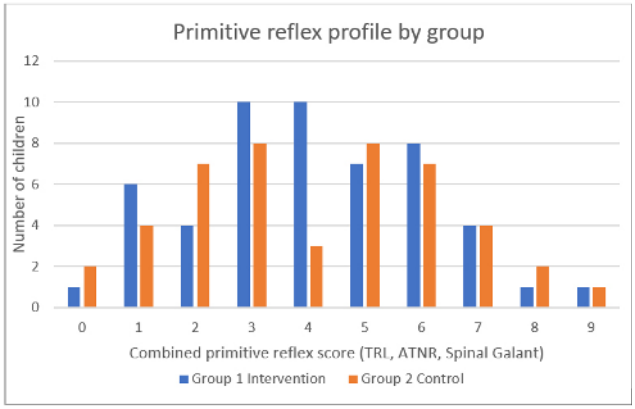

Figure 1: Primitive reflex profile scores for each group.

Table 1: Mean reflex profile scores.

	Reflex Profile Scores at Time 0 (Day 1)			Reflex Profile Scores at Time 1 (Mid-point Day 94)			Reflex Profile Scores at Time 2 (Completion Day 216)		
Group	Overall M (SD)	Males M (SD)	Females M (SD)	Overall M (SD)	Males M (SD)	Females M (SD)	Overall M (SD)	Males M (SD)	Females M (SD)
Control	4.11 (2.27)	4.29 (2.03)	3.91 (2.54)	3.48 (1.94)	3.63 (1.74)	3.32 (2.17)	2.24 (2.02)	2.38 (1.74)	2.09 (2.33)
Intervention	4.08 (2.04)	4.42 (2.23)	3.08 (1.80)	2.67 (1.64)	2.69 (1.52)	2.56 (1.79)	1.63 (1.58)	2.23 (1.66)	1.04 (1.28)
<4/week	3.99 (2.21)	4.34 (2.09)	3.64 (2.29)	3.32 (1.94)	3.57 (1.67)	3.08 (2.17)	2.50 (1.87)	3.18 (1.40)	1.96 (2.03)
>=4/week	4.37 (1.93)	4.40 (2.26)	4.33 (1.61)	2.33 (1.24)	2.13 (1.25)	2.58 (1.24)	1.31 (1.57)	1.61 (1.43)	0.90 (1.52)

Note. M = Mean, SD = Standard Deviation

Table 2: Coefficient estimates for reflex profile using model 2: frequency.

Reflex Profile	Estimate	Std - error	t-value	p-value
Expected response for the >=4/week group at Day 0	4.21	0.33	12.42	<0.0001
Expected difference in response of the <4/week and >=4/week groups at Day 0	-0.21	0.41	-.51	0.6040
Expected effect of adding days to the >=4/week group	-2.81	0.33	-8.36	<0.0001
Expected difference in the effect of adding days for <4/week and >=4/week groups	1.10	0.46	2.39	0.018*

Table 3: Coefficient estimates for reflex profile using model 1: group.

Reflex Profile	Estimate	Std - error	t-value	p-value
Expected response for the control group at Day 0	4.17	0.28	14.63	<0.0001
Expected difference in response of the intervention and control group at Day 0	-0.23	0.39	-0.58	0.5569
Expected effect of adding days to the control group	-1.88	0.28	-6.58	<0.0001
Expected difference in the effect of adding days for the intervention and control groups	-0.52	0.39	-1.33	0.1844

reflex profile scores of the children. Table 4 shows that there was no statistically significant difference between the reflex profiles of children in low SES and high SES, but there was a difference between the middle and low SES. The children in the middle SES school had slightly higher reflex profile scores than the low and high SES as is shown in Figure 2.

Findings and results – reading

Hermeneutic circles were used to establish the reoccurring themes in the qualitative data findings. This section focuses on student achievement findings, particularly concerning reading. Teacher comments were recorded throughout the 11 months of the research. With each class divided into a control and intervention group, most teachers did not notice differences in the group at five months. However, Betty, who was in a 69-child class with three teachers, had her whole class in the intervention group, and she observed that her parent interviews had a different flow that year. She observed that she had made the comment "Your child has discovered that he/she is a learner." to a greater number of parents than she would normally mid-way through the year. Gwen, a 25-child class with one teacher, was observed with a child mid-way through the year:

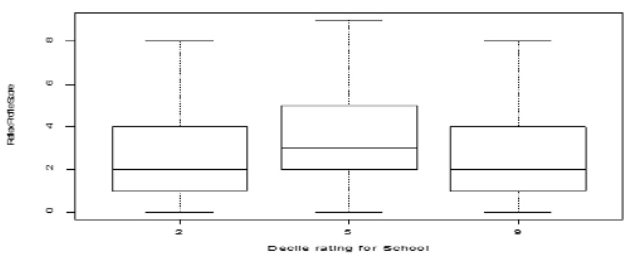

Figure 2: Boxplot showing reflex profile scores in relation to School SES rating.

> *Now (child) we need to spend some time working on your focus so that your work is easier for you to do. Are you doing T's exercises? (Child replied "No"). Hmm, that is interesting. (Teacher looked at me with an expression of puzzlement and interest, and then smiled) (Gwen).*

Gwen appeared to have connected the increase in focus of other children in the class, and this child with apparently less focus was not in the intervention group.

At the end of the research, the teacher comments had a noticeably different tone. Mildred, in a 49-child class with two teachers, made the following comments:

> *I can see the key competencies have increased, amazingly. Across the curriculum, we started out within (the class) two-thirds of the children, at and above in all subjects, so they were higher than a standard mix of children. But they are on track and continuing with that…They are just really confident in the things that they like to do. Which is lovely. I mean this child (pointing to a video of a child dancing) was completely shut down at the beginning of the year, quiet, and very anxious all the time when she first started school and now, this year because she's able to*

Table 4: Pairwise comparisons using t-tests with pooled SD.

	Low SES School (Decile 2)	Middle SES School (Decile 5)
Middle SES School (Decile 5)	p = 0.0096	
High SES School (Decile 9)	p = > .9999	p = 0.0760

be herself in the thing that she is extremely good at, and that confidence filters into other areas of the curriculum and she's just happy (Mildred).

The other teacher in this 49-child class, Iris, made the following comments about the class:

Just their confidence in themselves and being around other people. There were a lot of children that were not like that at the start of the year. So, we are writing reports for all of our Year 4's and anniversary and interims for all the other children. From where we started, we have got one child that was reading a level 4 at the start of the year who has shot up to level 14 reading. What they are doing is amazing. Mildred takes the high readers, she's got more at level 29 and 30 than we have below that which is wonderful, everyone has improved out of this world, it is just wonderful to see the results, and it is just lovely.

Researcher: And how does that compare to other years?

I have not seen such big jumps in children's achievement until this year. So yeah, it is lovely, lovely to see (Iris).

Gwen also made comments about general academic achievement. Her reference to stanines indicates the recording of Progressive Achievement Tests used in NZ schools. Scaled scores were created from raw test scores and these were placed on a nine-level achievement scale for the year group. Moving one or two stanines in a year is a good result, but moving three stanines, as reported by Gwen, is considered excellent progress:

Very well academically, yes, they have all made some large gains. My special needs student, in particular, has made astounding progress. But they have all made some gains. Even kids, with behavioural needs. They have still managed to make some gains. Some children have jumped three stanines (Gwen).

Mildred noticed changes in her group concerning reading:

We have had the oral and interactive type part of literacy improve as they have more voice, and more opportunities to interact as opposed to just necessarily listening to a teacher all the time. So that has increased vocabulary really and that all plays out in literacy. I think they are doing really well. They are continuing to track above and continuing above, there is no plateauing that we are seeing at all, apart from maybe two that have learning difficulties (Mildred).

Agatha was in an 18-child class and made the following comments about the reading progress she had observed:

Yes, more than I am used to. I think a few years ago we started the Early Words programme, and so that's been going now for four years, running alongside our programme, but even so, I think the exercises have certainly increased their (the children's) ability to focus for longer or the way that it is all clicking, I don't know, I can't explain it, but I certainly feel there is a noticeable difference (Agatha).

She then spoke to a graph she had where current children's reading progress was compared with previous years:

When they came to school, sometimes they were in magenta for most of a term, but now I am finding that they are going into reds and yellows quite quickly, and they are making huge jumps. So, for instance, (this year) the range is better than the past, the range is turquoise and orange whereas here it is lots of children in the (blue and green) 20s like A (child), he went up to level 23 (Agatha).

The reading levels used in NZ schools can be found as part of the Ministry of Education resources [46].

The general perceptions of teachers were that their children's overall reading progress through the levels was greater than they had noticed in previous years. The results in the next section support these comments.

Teachers completed testing at three points during the research: beginning, middle, and end. Table 5 shows the mean scores for the three test points. The initial scores of the control group, 9.65 (3.86), increased to 12.70 (4.53), while the intervention group went from 8.27 (3.43) to 11.31 (3.45). The frequency of times the movements were completed each week was factored in, and the group using RMT for four or more times per week went from 9.22 (3.56) and moved to 13.96 (4.59), and the group using RMT for less than four times per week went from 8.80 (3.60) to 10.46 (2.17).

Table 6 shows that the control group reading scores increased on average by 3.05, and the intervention group increased by 3.42 during the research. A statistically significant difference between the groups was not detected (p= 0.3763).

However, in Table 7, the statistical model included frequency of movement completion as a factor. This meant that a statistically significant difference was detected (p = 0.0020) between the group that completed the movements four or more times per week and those that completed the movements less than four times per week. Reading scores for the 'four or more' group increased by 4.04 units, and the 'less than four' group increased by 2.52 units.

Table 5: Mean reading scores.

	Reading Scores at Time 0 (Day1)			Reading Scores at Time 1 (Mid-point Day 94)			Reading Scores at Time 2 (Completion Day 216)		
Group	Overall M (SD)	Males M (SD)	Females M (SD)	Overall M (SD)	Males M (SD)	Females M (SD)	Overall M (SD)	Males M (SD)	Females M (SD)
Control	9.65 (3.68)	10.46 (3.48)	8.77 (3.77	10.80 (3.37)	11.58 (3.67)	9.95 (3.68)	12.70 (4.53)	13.71 (4.72)	11.59 (4.12)
Intervention	8.27 (3.43)	8.23 (3.67)	7.89 (3.25)	9.87 (4.06)	10.04 (4.54)	9.69 (3.60)	11.71 (4.02)	12.12 (4.55)	11.31 (3.45)
<4/week	8.80 (3.60)	9.40 (3.62)	8.22 (3.54)	9.92 (3.67)	10.51 (3.67)	9.33 (3.62)	10.46 (2.17)	10.77 (1.85)	10.21 (2.39)
>=4/week	9.22 (3.56)	9.07 (4.04)	9.42 (3.20)	11.33 (4.41)	11.40 (5.26)	11.25 (3.28)	13.96 (5.14)	14.54 (5.50)	13.15 (4.59)

Note. M = Mean, SD = Standard Deviation.

Table 6: Coefficient estimates for reading using model 1: group.

Reading	Estimate	Std - error	t-value	p-value
Expected response for the control group at Day 0	9.59	0.53	18.05	<0.0001
Expected difference in response of the intervention and control group at Day 0	-1.28	0.72	-1.75	0.0824
Expected effect of adding days to the control group	3.05	0.30	9.96	<0.0001
Expected difference in the effect of adding days for the intervention and control groups	0.37	0.42	0.88	0.3763

Table 7: Coefficient estimates for reading using model 2: frequency.

Reading	Estimate	Std - error	t-value	p-value
Expected response for the >=4/week group at Day 0	8.93	0.49	17.89	<0.0001
Expected difference in response of the <4/week and >=4/week groups at Day 0	0.02	0.47	0.05	0.9588
Expected effect of adding days to the >=4/week group	4.04	0.36	11.14	<0.0001
Expected difference in the effect of adding days for <4/week and >=4/week groups	-1.52	0.48	-3.14	0.0020**

Discussion

Retained primitive reflexes are an identified issue for some children across all SES levels. With increased levels of stress and limitations restricting movement placed on families through the COVID-19 control measures, teachers may see a decrease in academic skills and an increase in social and emotional challenges. When children have retained primitive reflexes, they find physical skills associated with reading challenging [47-49]. Thelen's [23] theories focus on regular movement opportunities for infants as neurological development progresses. She demonstrated that infants used movement to achieve goals and that this process facilitated brain maturation. When this theory is combined with the phenomenon of retained primitive reflexes where movement is used for reflex integration, there is a possibility that the quality of movement experiences early in life will then impact achievement and behavioural outcomes in the primary school years and beyond. This suggests that early intervention with infants to ensure a range of high-quality movement opportunities would be optimal. Parents and teachers need to factor this into children's daily programmes. However, this research focused on school-aged children who arrived at school with primitive reflexes still in place. As the literature implies, there is an association between retained primitive reflexes and academic outcomes for children. If taking a 'bottom-up' approach to development, it would appear that working to address early movement deficits through a primitive reflex-integration programme would potentially reduce some challenges faced by children at school.

Research using reflex integration programs such as INPP [28] and Primary Movement Program [21, 30] have shown improvements in reading, writing, mathematics, and spelling. While these programmes used different movements, and the time completing the research was longer, the RMT results also show improvements in reading and reduced reflex profile scores. This range of research information supports the use of reflex integration programs and increases the options available to teachers.

Donovan and Radosevich's [25] Distributed Practice Theory supports the need for short practices, often, as a way to increase skills. This theory implies that a movement based intervention for retained primitive reflexes is likely to have the greatest effect. Still, the programme needs to be completed often and regularly, just as a baby prefers to move as often as possible. This means that an intervention programme needs to be easy for teachers to implement with a small time allocation to achieve results. The results reported were achieved when RMT was used four or more times a week, supporting Distributed Theory Practice. Significant improvements were observed when a movement programme [50] of 30 minutes was used three or more times each week over ten months. In this research, the findings indicate that RMT aligns with this need for short practices over an extended period when used generically in a classroom.

Williams [50] found that children engaged in a movement programme improved their reading scores during the

year of the research when compared to a control group. When children engaged with the RMT movements four or more times each week, this research found a statistically significant improvement in their reading scores. Teachers also commented on the positive changes they noticed in their children's reading. The children in this research had elevated reflex retention profiles, possibly triggered by earthquakes many of the children had experienced. Stress is considered to be a factor in the retention of reflexes [5, 45], as shown in the high reflex profile scores of the children who had experienced an earthquake. This has implications for children experiencing other disasters/pandemics/war or high stress levels, particularly pre- and post-birth [51-53]. Rather than focusing resources on skill deficits, this research suggests that some focus on retained primitive reflexes would effectively improve reading outcomes for children. The group of six to eight-year-olds in this research engaged with the movements, but it is possible that it may be more challenging to get older children to participate at the same levels. Using the intervention with younger children would be seen as early intervention. Further research in this area would be needed to establish how this could be implemented and which techniques were effective.

Limitations

The research design and the testing requirements in the NZ education system were the two main limitations of this research. As already indicated, useful data was gained after five months of intervention when only the intervention group completed the movements. Research from other sources cited in this article all lasted for one school year, and groups were defined by individual classrooms, meaning that the teacher effect could be a factor. However, this research shows that after five months of using the movements, a statistically significant change was observed in the reading scores. It is not clear if the movements were the cause of the changes, but matching groups for gender and SES and having multiple teachers teaching the children, suggests that this is worthy of further investigation.

The second limitation was the testing used in the research. Due to the need to test children's reflexes, it was decided to use the NZ National Standards testing completed by classroom teachers. The effort to ensure young children were not over-tested was considered acceptable, alongside the fact that this was regarded as exploratory research in an area with limited evidence. Further research would need to use independent standardised testing. Changing the research design to the format used by other researchers, a whole classroom of children in the same group, would mean testing could be completed twice during the data gathering, thus reducing student test fatigue.

Conclusion

This article recommends that retained primitive reflexes should be considered by teachers and parents when monitoring student achievement, in this case reading. This is particularly relevant during the global pandemic with the associated stress and restrictions. For some children, the basis of their challenges could be grounded in their reflex system's immaturity. When this is the case, it would be appropriate to include a reflex integration programme within the range of strategies used to help increase learning outcomes. This research has investigated the use of the reflex integration programme RMT to increase reflex maturity in children. Results show a decrease in the retention of four of the children's primitive reflexes, and there was a statistically significant increase in the children's reading scores. This indicates that the five minutes per day, four or more times per week, is a useful investment of time for the student and the teacher.

References

1. Russell BS, Hutchison M, Tambling R, Tomkunas AJ, Horton AL. 2020. Initial challenges of caregiving during COVID-19: caregiver burden, mental health, and the parent–child relationship. *Child Psychiatry Hum Dev* 51(5): 671-682. https://doi.org/10.1007/s10578-020-01037-x
2. North CS. 2016. Disaster mental health epidemiology: methodological review and interpretation of research findings. *Psychiatry* 79(2): 130-146. https://doi.org/10.1080/00332747.2016.1155926
3. Deoni SC, Beauchemin J, Volpe A, D'Sa V. 2021. Impact of the COVID-19 pandemic on early child cognitive development: initial findings in a longitudinal observational study of child health. medRxiv. https://doi.org/10.1101/2021.08.10.21261846
4. Gieysztor EZ, Choińska A, Paprocka-Borowicz M. 2018. Persistence of primitive reflexes and associated motor problems in healthy preschool children. *Arch Med Sci* 14(1): 167-173. https://doi.org/10.5114/aoms.2016.60503
5. Goddard S. 1996. A Teacher's Window into the Child's Mind and Papers from the Institute for Neuro-Physiological Psychology: A Non-Invasive Approach to Solving Learning and Behavior Problems. Fern Ridge Press.
6. McPhillips M, Sheehy N. 2004. Prevalence of persistent primary reflexes and motor problems in children with reading difficulties. *Dyslexia* 10(4): 316-338. https://doi.org/10.1002/dys.282
7. Matuszkiewicz M, Gałkowski T. 2021. Developmental language disorder and uninhibited primitive reflexes in young children. *J Speech Lang Hear Res* 64(3): 935-948. https://doi.org/10.1044/2020_JSLHR-19-00423
8. Konicarova J, Bob P. 2013. Principle of dissolution and primitive reflexes in ADHD. *Act Nerv Super* 55: 74-78. https://doi.org/10.1007/BF03379598
9. Konicarova J, Bob P. 2013. Asymmetric tonic neck reflex and symptoms of attention deficit and hyperactivity disorder in children. *Int J Neurosci* 123(11): 766-769. https://doi.org/10.3109/00207454.2013.801471
10. Konicarova J, Bob P. 2012. Retained primitive reflexes and ADHD in children. *Act Nerv Super* 54: 135-138. https://doi.org/10.1007/BF03379591
11. Blomberg H, Dempsey M. 2011. Movements That Heal: Rhythmic Movement Training and Primitive Reflex Integration. BookPal Publishing.
12. Blomberg H. 2015. The Rhythmic Movement Method: A Revolutionary Approach to Improved Health and Well-Being. Lulu Publishing.
13. Grigg TM, Fox-Turnbull WH, Culpan I. 2018. Retained primitive reflexes: perceptions of parents who have used Rhythmic Movement Training with their children. *J Child Health Care* 22(3): 406-418. https://doi.org/10.1177/1367493518760736
14. Franz EA, Gillett G. 2011. John Hughlings Jackson's evolutionary neurology: a unifying framework for cognitive neuroscience. *Brain* 134(10): 3114-3120. https://doi.org/10.1093/brain/awr218
15. Furfey PH, Bonham MA, Sargent MK. 1930. The mental organization of the newborn. *Child Development* 1(1): 48-51. https://doi.org/10.2307/1125617

16. Capute AJ, Shapiro BK, Accardo PJ, Wachtel RC, Ross A, et al. 1982. Motor functions: associated primitive reflex profiles. *Dev Med Child Neurol* 24(6): 662-669. https://doi.org/10.1111/j.1469-8749.1982.tb13677.x

17. Capute AJ, Palmer FB, Shupiro BK, Wuchtel RC, Ross A, et al. 1984. Primitive reflex profile: a quantitation of primitive reflexes in infancy. *Dev Med Child Neurol* 26(3): 375-383. https://doi.org/10.1111/j.1469-8749.1984.tb04456.x

18. Hadders-Algra M. 2022. Two distinct forms of minor neurological dysfunction: perspectives emerging from a review of data of the Groningen Perinatal Project. *Dev Med Child Neurol* 44(8): 561-571.

19. Hadders-Algra M, Heineman KR, Bos AF, Middelburg KJ. 2010. The assessment of minor neurological dysfunction in infancy using the Touwen Infant Neurological Examination: strengths and limitations. *Dev Med Child Neurol* 52(1): 87-92. https://doi.org/10.1111/j.1469-8749.2009.03305.x

20. Rider BA. 1972. Relationship of postural reflexes to learning disabilities. *Am J Occup Ther* 26(5): 239-243.

21. McPhillips M, Hepper PG, Mulhern G. 2000. Effects of replicating primary-reflex movements on specific reading difficulties in children: a randomised, double-blind, controlled trial. *Lancet* 355(9203): 537-541. https://doi.org/10.1016/s0140-6736(99)02179-0

22. McPhillips M, Jordan-Black JA. 2007. Primary reflex persistence in children with reading difficulties (dyslexia): a cross-sectional study. *Neuropsychologia* 45(4): 748-754. https://doi.org/10.1016/j.neuropsychologia.2006.08.005

23. Thelen E. 1981. Rhythmical behavior in infancy: an ethological perspective. *Dev Psychol.* 17(3): 237-257. https://doi.org/10.1037/0012-1649.17.3.237

24. Thelen E, Corbetta D, Spencer JP. 1996. Development of reaching during the first year: role of movement speed. *J Exp Psychol Hum Percept Perform* 22(5): 1059-1076. https://doi.org/10.1037//0096-1523.22.5.1059

25. Donovan JJ, Radosevich DJ. 1999. A meta-analytic review of the distribution of practice effect: now you see it, now you don't. *J Appl Psychol* 84(5): 795-805. https://doi.org/10.1037/0021-9010.84.5.795

26. Leisman G, Moustafa AA, Shafir T. 2016. Thinking, walking, talking: integrative motor and cognitive brain function. *Front Public Health.* 4: 94. https://doi.org/10.3389/fpubh.2016.00094

27. McPhillips M, Jordan-Black JA. 2007. The effect of social disadvantage on motor development in young children: a comparative study. *J Child Psychol Psychiatry* 48(12): 1214-1222. https://doi.org/10.1111/j.1469-7610.2007.01814.x

28. Blythe SG. 2005. Releasing educational potential through movement: a summary of individual studies carried out using the INPP Test Battery and Developmental Exercise Programme for use in schools with children with special needs. *Child Care Pract* 11(4): 415-432. https://doi.org/10.1080/13575270500340234

29. Callcott D. 2012. Retained primary reflexes in pre-primary-aged indigenous children: the effect on movement ability and school readiness. *Australas J Early Child* 37(2): 132-140. https://doi.org/10.1177/183693911203700218

30. Brown CG. 2010. Improving fine motor skills in young children: an intervention study. *Educ Psychol Pract* 26(3): 269-278. https://doi.org/10.1080/02667363.2010.495213

31. Blythe SG. 2012. Assessing Neuromotor Readiness for Learning: The INPP Developmental Screening Test and School Intervention Programme. Wiley-Blackwell, Hoboken, NJ.

32. Jordan-Black JA. 2005. The effects of the Primary Movement programme on the academic performance of children attending ordinary primary school. *J Res Spec Educ Needs* 5(3): 101-111. https://doi.org/10.1111/j.1471-3802.2005.00049.x

33. Training Requirements for Primary Movement Programme. [http://primarymovement.org/about/index.html][Accessed February 26, 2023]

34. Taylor M, Houghton S, Chapman E. 2004. Primitive reflexes and attention-deficit/hyperactivity disorder: developmental origins of classroom dysfunction. *Int J Spec Educ* 19(1): 23-37.

35. Education Counts. New Zealand Schools Directory Wellington: Ministry of Education. 2017. [https://www.educationcounts.govt.nz/directories/list-of-nz-schools] [Accessed February 26, 2023]

36. Salzer R. 1986. Why not assume they're all gifted rather than handicapped? *Educational Leadership* 44(3):74-77.

37. Ministry of Education. National Standards: Overall Teacher Judgement. Wellington, New Zealand. [https://nzcurriculum.tki.org.nz/Archives/Assessment/National-Standards-archives/Fact-sheets/Overall-teacher-judgment] [Accessed February 26, 2023]

38. R Foundation for Statistical Computing. [https://www.r-project.org/] [Accessed February 26, 2023]

39. Pinheiro J, Bates D, DebRoy S, Sarkar D, R Core Team. [https://cran.r-project.org/web/packages/nlme/index.html] [Accessed February 26, 2023]

40. Winter B. 2013. Linear models and linear mixed-effects models in R with linguistic applications. *arXiv preprint*. https://doi.org/10.48550/arXiv.1308.5499

41. Bogdan R, Biklen SK.2006. Qualitative Research for Education. An Introduction to Theories and Methods. Fifth edition. Pearson Education Inc and Allyn & Bacon, Boston, MA.

42. Creswell JW, Poth NC. 2013. Qualitative Inquiry and Research Design - Choosing Among Five Approaches. Third edition. Sage, Publications Inc, London.

43. Douglas E. 2002. Qualitative Analysis: Practice and Innovation. Routledge, Taylor & Francis group.

44. Grzywniak C. 2017. Integration exercise programme for children with learning difficulties who have preserved vestigial primitive reflexes. *Acta Neuropsychologica* 15(3): 241-256. https://doi.org/10.5604/01.3001.0010.5491

45. Blythe SG. 2008. What Babies and Children Really Need: How Mothers and Fathers Can Nurture Children's Growth for Health and Well Being. Hawthorn Press.

46. Assessment resources map - Reading. Wellington, New Zealand Government.[https://assessment.tki.org.nz/Assessment-tools-resources/Assessment-resources-maps] [Accessed February 26, 2023]

47. Ayres AJ. 2005. Sensory Integration and the Child: Understanding Hidden Sensory Challenges. Western psychological services.

48. Sassé M. 2009. Smart Start: How Eexercise can Transform your Child's Life. Exisle Publishing.

49. Blythe SG. 2005. The Well-Balanced Child: Movement and Early Learning. Hawthorn Press.

50. Williams J. 2015. Does a neurodevelopmental movement program affect Australian children's academic performance? Unlocking potential: a report. *Australian Journal of Child and Family Health Nursing* 12(2): 12-18.

51. Mutch C. 2017. Winners and losers: School closures in post-earthquake Canterbury and the dissolution of community. *Waikato Journal of Education* 22(1). https://doi.org/10.15663/wje.v22i1.543

52. Rucklidge JJ, Andridge R, Gorman B, Blampied N, Gordon H, et al. 2012. Shaken but unstirred? Effects of micronutrients on stress and trauma after an earthquake: RCT evidence comparing formulas and doses. *Hum Psychopharmacol* 27(5): 440-454. https://doi.org/10.1002/hup.2246

53. Thornley L, Ball J, Signal L, Lawson-Te Aho K, et al. 2015. Building community resilience: learning from the Canterbury earthquakes. *Kotuitui: New Zealand Journal of Social Sciences* 10(1): 23-35. https://doi.org/10.1080/1177083X.2014.934846