Evaluating the effectiveness of the Fit2Learn motor sensory integration programme on children's capacity to learn

Supplementary Report

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Prepared for:

The Linder Foundation

By

Leeds Beckett University

(Carnegie School of Sport & Carnegie School of Education)

Report prepared by:

Dr Tom van Rossum: Senior Lecturer Physical Education at Carnegie School of Sport, Leeds Beckett University.

Paul Ogilvie: Course Director of PGCE Secondary at Carnegie School of Education, Leeds Beckett University.

ACKNOWLEDGEMENTS

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BACKGROUND

Many children in the UK are trying to cope with the demands of the schooling system without full sensory integration. The includes:

1. Motor skills: postural control and bi-lateral integration of motor skills, which should be in place by 7 years old, are absent
2. 80% of children under 5 years old experience an inner ear infection (Berman, 1994) which suppresses the inner ear's ability to process sound. This sound processing abilities are not checked or on the national agenda despite the impact on global development via the vestibular system
3. Binocular vision and visual processing skills are not checked or on anyone's agenda
4. With the retention of primitive reflexes, a child may never reach their full cognitive potential (Berne, 2006).

These are the foundation of proprioception (i.e. the sense of where one is in space) which can increase anxiety and sense of well-being.

PURPOSE

We worked with a small group of young people in alternative provision and secondary school settings who were recognised to be at risk from poor emotional and mental wellbeing, to improve their development and confidence, and subsequently, their capacity to learn.

Within this project, the young people took part in a range of specific activities designed by Fit2Learn in school to help their motor-sensory development. By providing this targeted support to young people, this program was intended to improve their future opportunities by providing them with the readiness to learn, and improve their movement competence, self-confidence and motivation to make more positive life choices, influencing their future education and employment.

The Fit 2 Learn program has proven to be successful in supporting children to overcome motor skill deficiencies and improve their sensory system. This has enabled the children to become more functional learners and engage better within a mainstream learning environment.

RESEARCH AIMS

The research objectives are three-fold:

1. Examine the relationship between completing the Fit2Learn program and children's readiness to learn.
2. Examine how completing the Fit2Learn program influences children's engagement in the classroom.
3. Evaluate the feasibility of the Fit2Learn program being implemented in school by teachers.

METHODOLOGY

The study occurred over a 6-months, from May to December 2022. The participants were pupils (n=12) from two schools in the North West of England: one mainstream secondary school (School A) and one special school (School B). The study was originally planned to take place in the first half of 2021 but this prevented by COVID-19 health guidance restricting access into schools.

The study was a mixed methods approach to capture children's motor skills, primitive reflexes, visual and sound processing, emotional well-being, readiness to learn and engagement in the classroom. This was captured by using standardised and validated measurements tools (questionnaires and test batteries) to measure children’s competence and confidence and semi-structured interviews with teachers. We interviewed teachers at the end of the intervention to explore their perceptions of delivering the intervention and their observations of the children’s engagement in the program.

In each school, we worked with small groups of children who have poor motor-sensory development/integration. Each school was asked to identify up to 8 children who were disengaged from their learning, struggle with classroom learning and who demonstrate poor motor skills. School

A identified 8 pupils and School B identified 4 pupils. These children (and their parents/carers) were invited to participate in the intervention.

The participants were initially assessed for visual processing, audio processing, motor skills, primitive reflexes, emotional and mental wellbeing, fundamental movement skills competence, readiness to learn and perceived fundamental movement skills competence (the standardised measures that will be used are detailed below). This baseline testing was conducted in school by the director of Fit2Learn and two members of the research team from the University.

The participants were led through the Fit2Learn program of resources and interventions over the course of 6 months to develop their primitive reflexes, gross motor competence, vision and sound processing. The daily activities (for motor skill development, sensory processing) were delivered by staff in the school who were trained by the Fit2Learn director prior to commencement of the project. All equipment needed was provided to the school by Fit2Learn and the research team at the University. These activities were completed in the classroom or similar available space in the school. The experimental groups were monitored at intervals of 2-3 months and re-tested for motor skills, primitive reflexes, audio and visual processing at these testing points.

<u>The measurement tools are detailed below:</u>

- Visual Processing - Visagraph®
- Audio processing - Tomatis® Testing protocol
- Motor skills - Fit2Learn assessment protocol
- Primitive reflexes - Fit2Learn assessment protocol
- Readiness to Learn - Tansley Test and Wechsler intelligence scale for children (Wechsler, 1992)
- Fundamental movement skills competence - Canadian Agility and Movement Skills Assessment (Longmuir et al., 2017)
- Perceived fundamental movement skills competence - Pictorial Scale of Perceived Movement Skill Competence (Barnett, 2016)
- Classroom engagement - semi-structured interviews with teachers

Ethical considerations were discussed with our Local Research Ethics Committee and, after several questionnaire drafts to improve clarity and understanding, our final draft was approved for distribution.

KEY FINDINGS

The findings are presented in three parts:

Part 1: Baseline testing: A summary of the baseline testing for children who were evaluated using the Fit2Learn motor sensory integration protocol

Part 2A: Summary of overall changes to pupils' motor sensory integration measured at regular intervals during and upon completion of the Fit2Learn programme. of overall changes to pupils' motor sensory integration

Part 2B: Teachers' perceptions, experiences and observations of changes in children's engagement in the classroom. These reflections are comprised of first-hand accounts of the teachers' observations of children in school and reports from other staff members within the school during and upon completion of the Fit2Learn programme.

Part 1: Baseline testing; A summary of the baseline testing for children who were evaluated using the Fit2Learn motor sensory integration protocol

Baseline testing of the 12 children using the Fit2Learn protocol illustrated that all children had developmental challenges with motor-sensory integration. This was evident in the following ways:

i. Motor Skills: retained primitive reflexes; bilateral integration of motor skills and postural control
ii. Sound Processing: Suppressed and confused
iii. Binocular vision and visual processing: limited to very limited
iv. Cognitive processing skills: restricted by problems with motor skills, sound processing and visual processing;

At completion of the baseline testing, an individual report was produced for each child and shared with the school. The report was used by the Fit2Learn director to design an individualised program to focus on the specific areas of motor sensory integration to meet the needs of that child that was then delivered in school each day for the 6 month intervention period.

Part 2A: Summary of overall changes to pupils' motor sensory integration, movement competence and perceived competence upon completion of the Fit2Learn programme.

<u>Motor sensory integration</u>

As the results are based on individual engagement and progress it is difficult to give a very accurate, overall result to this project. However, after two rounds of Tomatis Sound Therapy and forty days of movement therapies and eye exercises, the headline findings at the end of the intervention were:

- All pupils' sound processing improved (some significantly) as a result of two rounds of Tomatis Sound Therapy. This will help their brain process the sounds (e.g., instructions) they hear during the school day and especially in the classroom, where they can make more sense of their environment.
- Some pupils improved (strengthened) their posture which will impact on visual control and sound processing.
- Some pupils made progress with control of their eye muscles which will help them concentrate and feel less tired in class.
- Some have improved mid-line crossing, although more work is required to master this skilfully (without involuntary head or body movements).
- Some can now hold binocular vision, although more work is required to master this skilfully.

For more detailed information about baseline testing, please refer to Appendix 1.

For more details about children's development over the whole project, please refer to Appendix 2.

Appendix 1 and 2 are examples of the individual reports that were produced for each child and were shared with the school.

Movement competence

Overall, all children identified to participate in the project had low levels of movement competence when measured at baseline. This is typical for children with retained poor motor sensory integration (Gieysztor, Choinska and Paprocka-Borowicz, 2018). Within two weeks of completion of the Fit2Learn intervention, children's movement skills were re-assessed in school. The results of the follow up assessments after completion of the Fit2Learn programme demonstrate that improvements were made to children's movement competence. This is significant due to the positive association between movement competence and educational outcomes (see Da Waal & Pienaar, 2020; Jaakola et al., 2015; Veldman et al., 2019) and increased physical activity and health-related fitness in children (Holfelder & Schott, 2014; Robinson et al., 2015; Stodden et al., 2008).

Perceived movement competence

At baseline testing, children's perceived movement competence was low across the participant group. At the point of follow-up testing in school, conducted within two weeks of the completion of the Fit2learn intervention, improvements were recorded to children's perceived movement competence. Overall, greater improvements were made to perceived competence than actual movement competence. Earlier research has indicated that perceived competence is a good indicator of physical activity levels (Bolger et al, 2018) and global self-worth (Bardid et al, 2016). Thus, there is a potential indirect benefit of the Fit2learn programme on children's outcomes through fostering their perceived competence.

Part 2B: Teachers' perceptions, experiences and observations of changes in children's engagement in the classroom

The perceived impact of this interventions was captured from 2 semi-structured interviews with the lead teacher from each school.

Theme 1: Rationale for participation:

School A has a lot of pupils with different mental health needs which may stem from an unknown trauma earlier in their life and when the lead teacher discovered it could address this, 12 pupils' names were obvious to them as participants Furthermore, they recognised that one challenge could be the Senior Leadership Team. In order to compensate for their perception of pupils' 'lost learning time', they would need to be convinced of the Fit2Learn intervention's potential benefits for their struggling pupils within an already congested school curriculum.

Similarly, School B found the original Fit2Learn presentation 'fascinating', that pupils could be identified as having underdeveloped multisensory integration throughout their childhood and that this could be *fixed*. Finally, School B, when considering the pupils who could be involved felt it was a chance to:

> '…raise the hopes and aspirations of participating pupils'

Teacher, School B

<u>Theme 2 Baseline Fit2Learn results:</u>

When some of the pupils were told their visual processing was not strong, which was probably contributing to poor concentration levels in class, some pupils were relieved to be able to make sense of their daily learning challenges.

> 'So, obviously, from Charlotte's screening the students was amazing'

Teacher, School B

<u>Theme 3: Feedback from class teachers:</u>

The overriding change in pupils was the level of confidence around school and in the classrooms. Furthermore, the participants' feedback that they could feel a positive change in themselves.

The intervention made a particular impact on Child HA a who had been labelled 'a pupil with poor concentrations levels. Based on her base-line sound processing, it was identified that, in a busy, noisy classroom, she would not be able to hear her own name due to the distractions. Child HA's teachers commented that, not only had her concentration levels improved but she was contributing in class.

> "This pupil used to be really quiet, she'd sit by herself and not say anything. After only 3 sound therapy sessions, she suddenly started answering questions and she asked if she could sit next to another student"

Teacher, School A

Another pupil, who is known to have regular meltdowns was able to self-regulate his emotions due to his planned sound processing therapy session:

> "He said, OK, I've got my sound therapy to look forward to this afternoon… that's my happy place"
>
> 'They really look forward to the session'

Teacher, School B

Child HB, who has cerebral palsy, was using her weaker arm for more aspects of school-life since the intervention had taken place, which her teacher suggested was due to improved performances in the motor skill exercises.

As a result of the sound processing, two pupils who enjoyed singing were now sufficiently confident to feature in the school's Christmas performance.

Finally, it was observed that a pupil, who was at the early stages of transitioning from one gender to another, was feeling more confident and comfortable in who she wanted to become and was happier fitting in with other pupils. Teachers reported that she felt less anxious about what other pupils were saying and thinking and was more talkative.

Theme 4: Challenges:

Despite being able to fit the sound processing into the curriculum, it did not leave time to also complete binocular vision and primitive reflex exercises. This resulted in instructions going home to parents to continue the intervention home but this resulted in inconsistencies.

School B had to work hard to convince their Senior Leadership Team that taking time away from curriculum-related interventions to participate in sound therapy was worthwhile and not all staff were convince as the outset. However, involving parents and sixth form students really helped to manage this process. There was also an attempt at logging what exercises parents did at home with their children but no one logged this information. Despite some early behavioural challenges during sound therapy sessions, when colouring and doodling was introduced, it helped to improve the pupils' attention.

Theme 5: Next steps:

One school planned to expand the programme to more pupils but, this time, ensure that the parents were more involved in the process. Despite the staff/parent training session that occurred at the start of the intervention, this was not monitored sufficiently. As a result of recognising the impact on the small group of participants, School B expressed their wish to screen every Year 7 pupil. This however had implications with time and funding.

Furthermore, School B planned to incorporate the prescribed primitive reflex exercises into Year 7 Physical Education warm-ups so that all pupils could access this.

CONCLUSION

The results of the project illustrate positive outcomes for children through completion of the Fit2Learn programme. Each individual child made improvement to their motor-sensory integration. In some cases, improvements were seen to children's movement competence and perceived competence, which are both associated to increased academic attainment and higher physical activity levels.

The purpose of the project was to evaluate the impact of the Fit2Learn programme on children's capacity to learn. The reports from teachers (presented in Part 2B above) provide significant evidence of how children's engagement in the classroom and attitude to their learning has improved. Previous evidence suggests that improving primitive reflexes and movement capacities can improve cognitive ability (Krog, 2011), thus unlocking children's potential to learn. The findings of this project illustrate that children's engagement and attitude towards learning in the classroom may be inhibited by poor motor sensory integration and that greater focus is needed in mainstream schools and alternative to identify and support children who have poor motor sensory integration.

Despite the progress evidenced with the children who took part in this project, further work and improvements are still required for all pupils in:

a) Improvements to postural control
b) Strengthening of the eye muscles

c) Crossing the mid-line with hand, eye and brain
d) Learn to use eyes and brain to see and process puzzles and problems
e) Some pupils need to strengthen their posture and develop the habit of sitting in an upright position, thus improving their visual control and sound processing

An unintentional, yet significant, finding from this project has highlighted that there are children in mainstream school settings who have poor motor-sensory integration. Previous studies (Krog; 2015; Krog and Kruger, 2011) within alternative provision provide data to suggest motor-sensory and movement interventions have helped to improve academic ability. Whereas, there is a paucity of research for children in mainstream schools where these issues are likely to be going unnoticed by teachers as motor-sensory development does not come under the National Curriculum for Primary or Secondary schools (Department for Education, 2013a; Department for Education, 2013b). Thus, it could be hypothesised that children with poor motor-sensory integration in mainstream settings are "going under the radar" and missing out on appropriate support to improve their cognitive function and capacity to learn. To address this disparity, school staff would benefit from motor-sensory integration training to correct motor functions (Gieysztor, Choińska and Paprocka-Borowicz, 2018) along with the inclusion of designated time in the school day to promote children's motor-sensory integration.

RECOMMENDATIONS

As a result of this research, we would recommend that further research is required to increase numbers of pupils and schools benefitting from the Fit2Learn approach so that:

- More schools and pupils learn about the impact of improving pupils motor sensory integration to give them the greatest chance of success in the classroom.
- More teachers are encouraged to understand that many children are low achievers because a lack of full sensory integration is preventing them from learning like others, despite the same levels of intelligence.
- An understanding of children's challenges regarding posture, sound processing, binocular vision and retained primitive reflexes should be shared with pre-service teachers.

- Senior Leaders should consider adapting their existing timetables to incorporate these therapies into their normal school day.
- The education authorities should stop being so quick to label conditions and instead, should check the obvious.

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Appendices

1. Example of Full Sensory Integration Progress Report for Pupil A
2. Example of Full Sensory Integration Baseline Report & Progress for Pupil SW1

Appendix 1: Example of Full Sensory Integration Progress Report for Pupil A

Pupil A: Interim Report 19 October 2022

Summary

Pupil A in May 2022 was identified as having developmental problems with:

Motor skills: retained primitive reflexes; bilateral integration of motor skills; and postural control.

Sound processing: suppressed and confused.

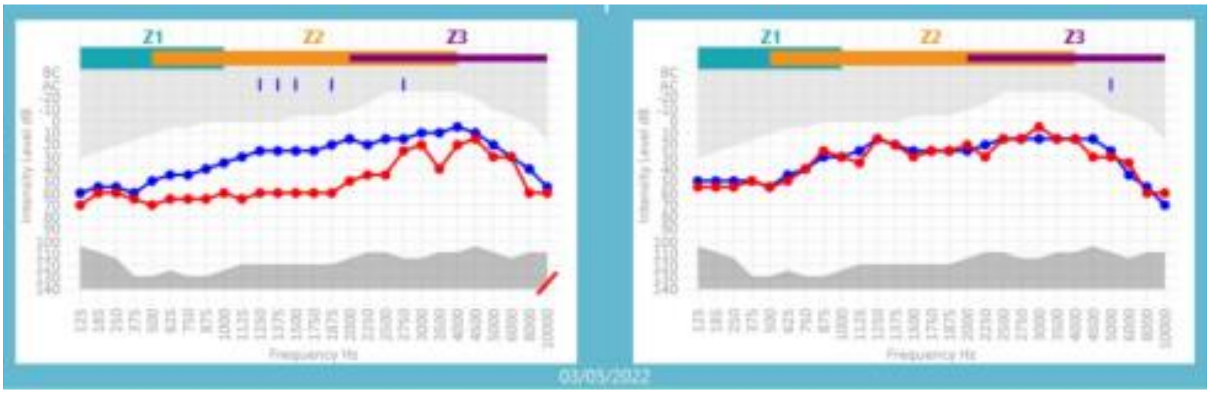
Binocular vision and visual processing: very limited.

Cognitive processing skills: restricted by problems with motor skills, sound processing and visual processing.

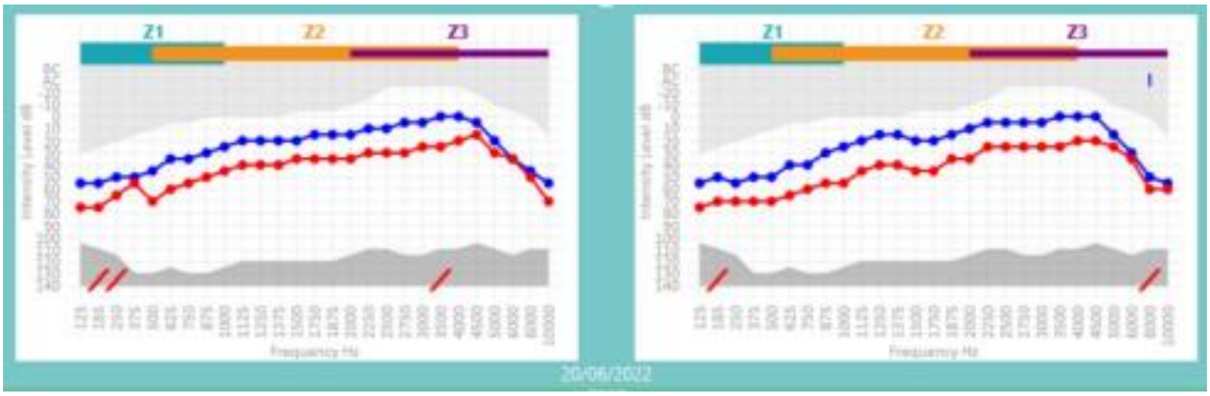
Progress to date:

- Pupil A has done some work on her motor skills control but needs to do more to establish midline crossing without good motor skills she cannot build higher level cognitive skills.
- Postural control is better but could be much more secure. Mia needs to learn to operate at all times with upright posture. Poor posture will impact on visual control and sound processing.
- Pupil A needs to work further to exercise and strengthen the muscles around her eyes.
- Pupil A's sound processing has improved significantly

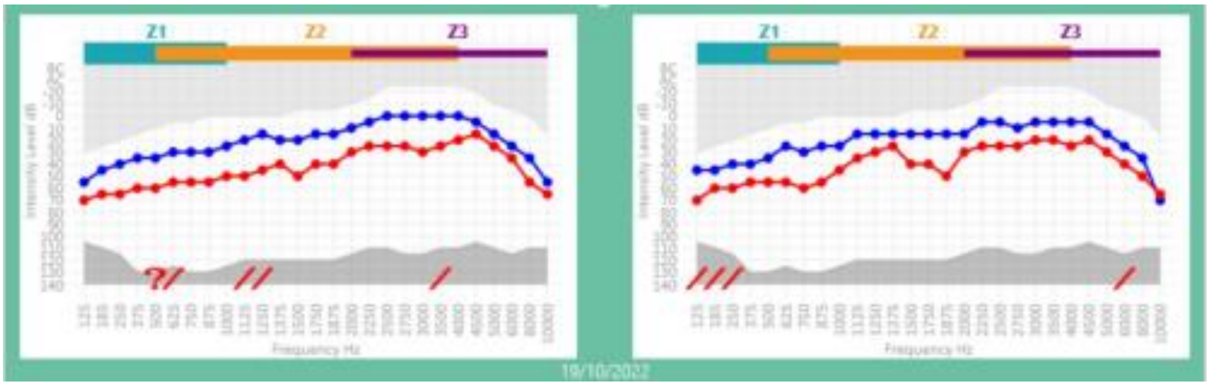
May 2022



June 2022



October 2022



Key to sound processing graphs

- Blue curves = sound processing on air conduction
- Red curves = sound processing on bone conduction

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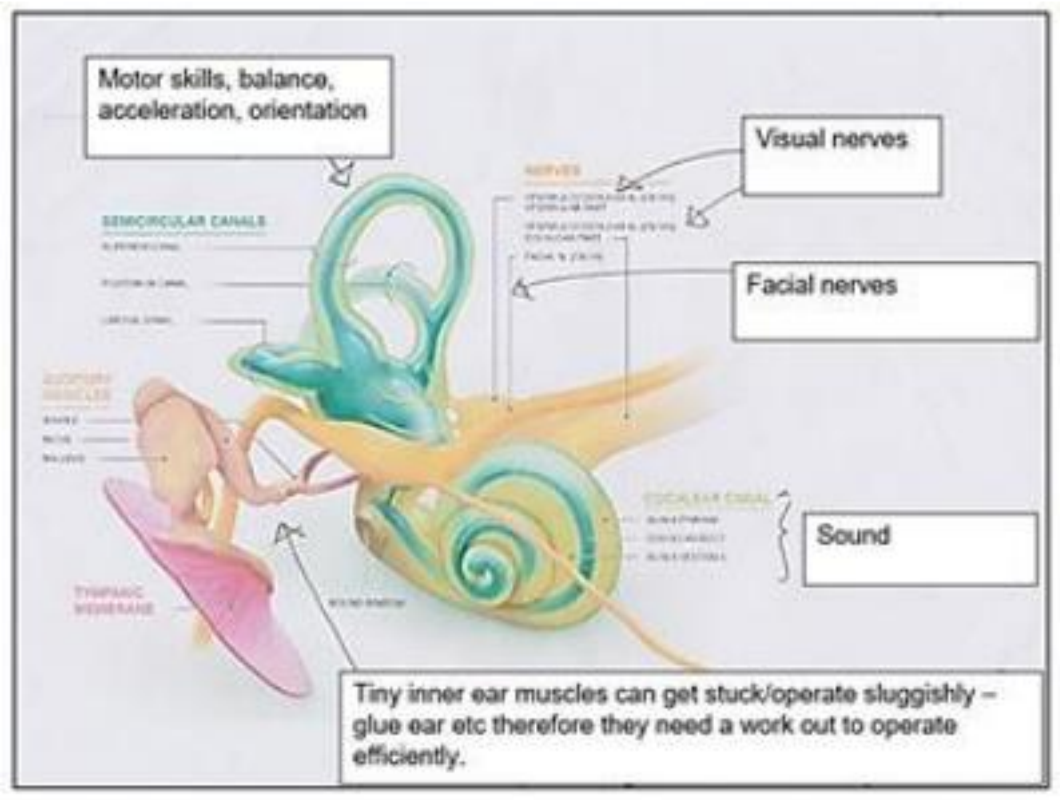
- Top grey curve indicates the ideal location for sound processing on air conduction (blue). The processing of sound using bone conduction should ideally lie 10Db below parallel.

Pupil A now has more coherent processing of sound. She could continue to improve, but the extreme problems have moved. Further work would also benefit vestibular integration, so will also speed up her integration of her senses and motor skills.



Agitating the vestibular system promotes holistic development as can be seen in the diagram above.

Urgent Action Points for Pupil A

1. Establish good mid-line crossing with motor skills and vision
2. Strengthen eyes muscles and work on mastering control of her visual skills.

3. Improve core strength and postural control. Ensure that Pupil A sits up or stands up straight throughout the day.
4. Undertake cognitive games and puzzles to improve mid-line crossing skills and ability to process visually. Specific tasks should include:
    1. learning to juggle with two then three balls, whilst keeping head and body still.
    2. Copying patterns in Q-Bitz row by row alternating hands and then repeating from memory.

Appendix 2: Example of Full Sensory Integration Baseline Report & Progress for Pupil SW1

Name: Pupil SW1

Date of screening: 3 May 2022

Assessor: Charlotte Davies, Fit 2 Learn (Charlotte.Davies@fit-2-learn.com)

NB: All images of the children have been removed from the report to protect their anonymity

Recommendations

1. SW1 would benefit from Fit 2 Learn's programme to help him develop his cognitive skills further so that his motor sensory integration works more smoothly and efficiently. This programme will take about 6 months to complete.

2. SW1 will undertake primitive reflex exercises to ensure good mid-line crossing of motor skills and postural control. Followed by a motor skills programme to ensure that he has full conscious use of all his motor skills.

3. He needs to undertake Tomatis sound processing therapy to improve his sound processing and vestibular integration.

4. SW1 will also undertake vision exercises to improve his vision and visual processing.

5. Further, he will engage in activities which help him to integrate all his senses and motor skills until they work together efficiently.

Summary

- SW1 is a keen young man but, at the moment, he is operating with quite restricted sound and vision processing, which must be exhausting.
- SW1 also has significant delays to his motor skills development which is all correctable if done in conjunction with sound and vision activities, then all systems will support each other's development.
- Once SW1 achieves motor-sensory integration he will be much calmer as he will not need to remain hyper-alert to cover up gaps in his cognitive processing which worry him.

Assessment Process: The assessment process comprises a set of exercises, tests and games to evaluate the client: Gross Motor Skills; Visual Development using Visagraph®; Auditory Development using Tomatis® Testing Equipment; Cognitive Development. See **Appendices** for information on the areas of development that have been assessed and reasons for selecting the tests that were performed.

Motor skills

Spinal Gallant reflex	Good
Moro reflex	Present
Asymmetric Tonic Neck reflex	Present
Tonic labyrinth Reflex	Needs strengthening
Skipping forwards & backwards	Struggles to work with opposing limbs
Throwing ball in an arc	Struggles to keep head and body still whilst crossing mid-line

Other notes	Quietly talks to himself

SW1 should undertake the following primitive reflex exercises every day for at least 40+ days:

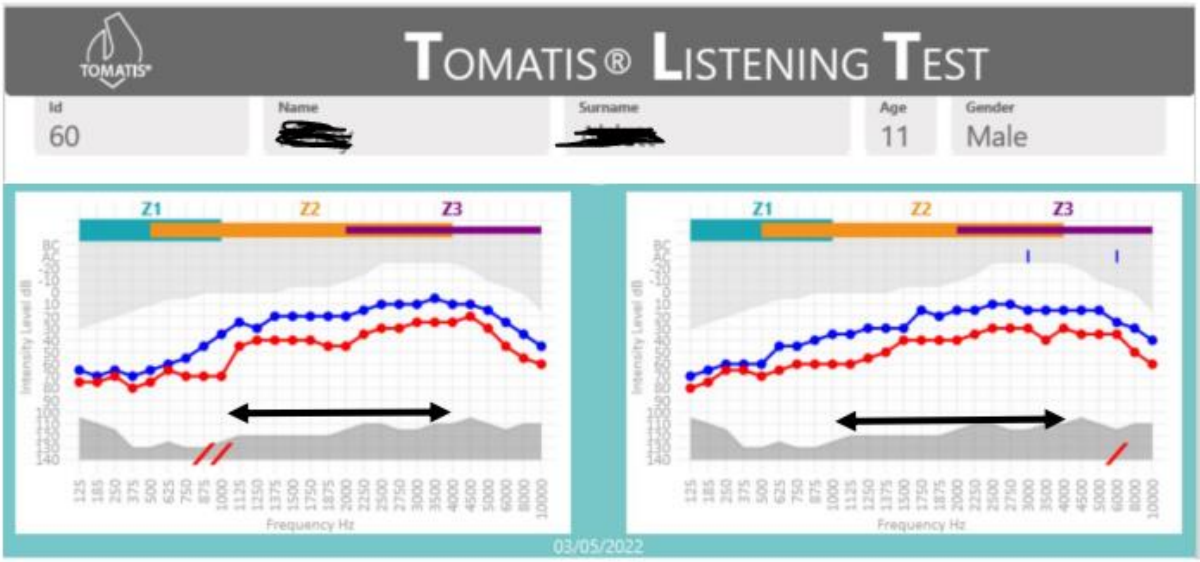
1. Moro reflex: https://www.youtube.com/watch?v=fQ4K9sw7by8
2. ATNR: https://www.youtube.com/watch?v=qm9NfP4cx0M
3. TLR: Meatball https://www.youtube.com/watch?v=P_C0YcuZS7k + Superman https://www.youtube.com/watch?v=krNwDklS_Ro
4. Improving his posture through undertaking exercises such as Squashed Frog (p13) pelvic tilts (p52) and working on establishing all aspects of good foot control and movement (p62-68)
5. Bi-lateral integration of motor skills exercise that can be found from pg38 onwards in the motor skills book, of particular interest are skipping forwards and backwards, also panther crawling (page 44 is very good), if done slowly, for helping people master bi-lateral integration of motor-skills.
6. Practice throwing a ball in an arc over the mid-line. This exercise requires the vision, the motor skills, and a sense of mid-line to work together.

Once the primitive reflex exercises are mastered then it is possible to train SW1 to move his eyes across his mid-line and master binocular vision.

If he does not master these exercises, they will continue to block his higher-level skills development.

Tomatis Auditory Processing Assessment

SW1's processing of sound through air (blue curve) and through bone (red curve). Grey curve at the top = ideal location of air conduction curve i.e., this is our objective; with bone conduction lying a consistent 10Db below with no clashes or big gaps between air and bone conduction of sound.



Laterality: struggles to follow sound when it moves

Selectivity: 0 on right side; 2 on left side. Being able to different changes in pitch is important for understanding nuances in both spoken and written language.

1,000hz to 4,000Hz is marked with an arrow as this is the main range for processing speech, problems in this area will impact disproportionately on any aspect of language processing.

Observations

SW1 is not processing sounds precisely across the whole sound range which makes it difficult for him to follow oral/aural instructions, conversations, and stories. He has quite suppressed sound processing in the main area for language processing on both left and right sides – at points the gap between the ideal and his actual is over 50 decibels.

Sound is an important part of proprioception i.e., knowing where you are in space. If there is a lot of background noise SW1 will feel threatened as he will lose/experience disruption to the sound processing, he does have.

Further, the differences between sound processing on left and right sides will make it hard for the ears to work together to process sound coherently. Henry has significant differences between the two sides.

SW1 has several clashes between his air and bone conduction of sound which will also impact on how coherently he processes sound. Further there are a few occasions on bone (***/*** or **?**) when SW1 is confused about the direction of sound.

Of significance there are dips on SW1's sound processing on both sides. Dips in sound processing can emotionally dysregulate a person. Henry will feel calmer and more grounded if his sound processing curves on both left and right sides move to coherent convex arcs, with no clashes between air and bone conduction of sound.

At the moment, SW1's processing of sound is a bit chaotic. It is important that we rescreen him before he starts his second round of therapy so that we can see how plastic his sound processing is. As SW1 improves his postural control and bi-lateral integration of motor skills this will support his sound processing skills. Conversely, improved sound processing supports improved motor skills and visual control, particularly peripheral vision.

SW1's problems with sound processing are making it very difficult for him to develop his global skills fully.

Visagraph Visual Tests

The client undertakes reading tests wearing Visagraph® goggles which measure how well the eyes are working, particularly whether they are working well together.

Focusing skills

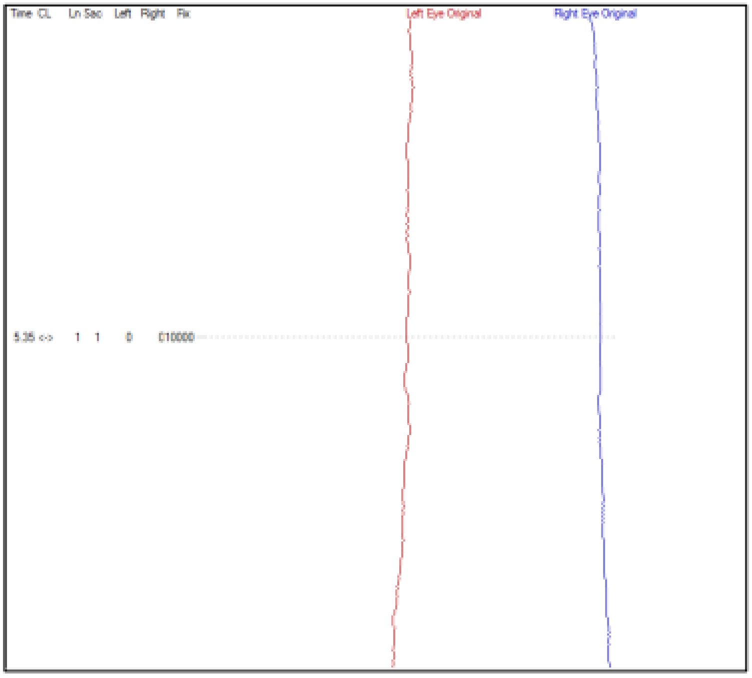
Fixation Profile ReadAlyzer

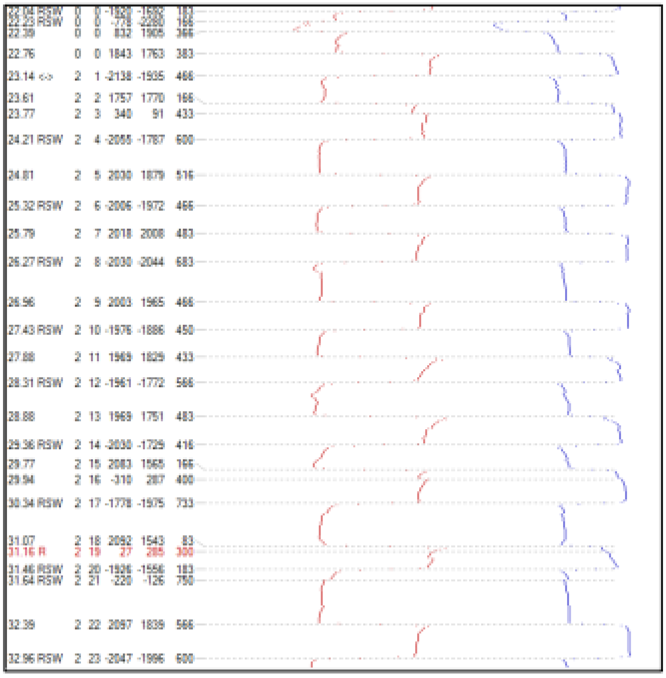
	Left	Right
Fixation maintenance (10 seconds)		
Fixations	1	1
Mean Saccade Size %	0	0
Motility (15 seconds)		
Excursions	27.1	
Fixations	32	32
Fixation Duration	0.47	0.47
Tracking (3 last lines)		
Fixations	26	26
Regressions	3	3
Fixation Duration	0.30	0.30
Completion Time (secs.)	7.81	

SW1 was asked to focus on a fixed point for 20 seconds. His eyes wavered slightly throughout, particularly his left eye. That will constantly disrupt his concentration and his ability to work with binocular vision.

SW1 is not skilled at maintaining a sharp focus on a fixed point.

The drift on each eye reflects that he needs to strengthen his eye muscles to achieve a really sharp focus. Improving postural control and mastering primitive reflexes will support this process.

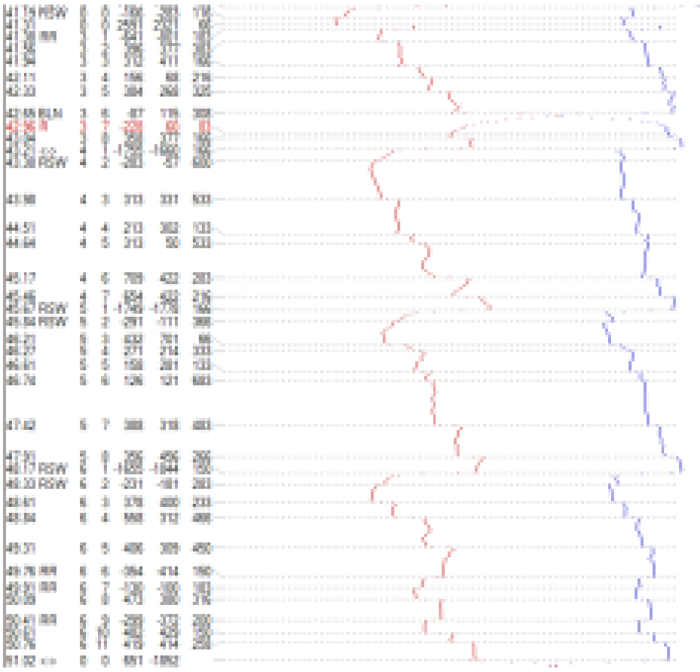




This test shows how well a person can change focus between two points. Both eyes move together, but the left eye moves more widely than the right eye. Henry habitually leans off to one side when working which causes the difference between the two eyes.

The eye movements are quite poorly defined and narrow. This indicates that there are issues with eye movements commonly associated with the asymmetric tonic labyrinth reflex. The ATNR can also cause the eyes to habitually jump at the mid-line.

Once the primitive reflexes are mastered and the individual eyes are strengthened Henry must learn to move his eyes more widely and precisely.



SW1 was asked to read the numbers 1 to 20 which were in large font print in four rows.

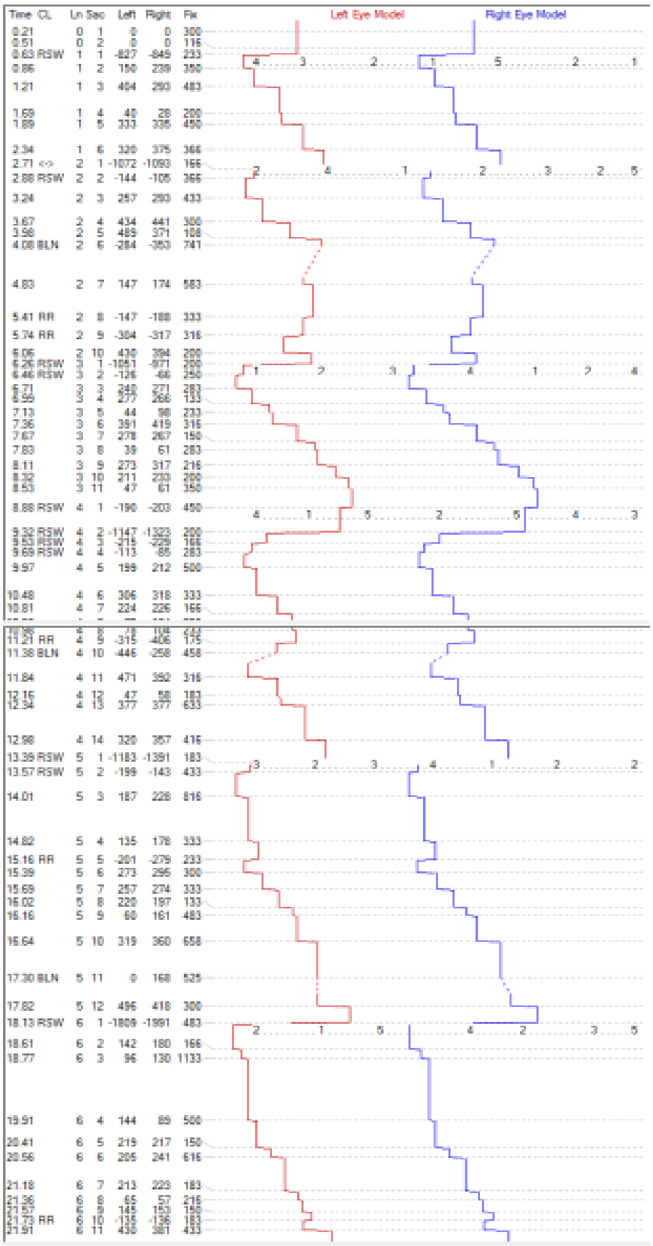
As can be seen from the screenshot SW1's eyes work reasonably well together reading large font numbers, but not perfectly. The eyes move in a stepped pattern, although not really together; the left eye moves more widely than the right. The eye movement for the four lines is obvious, but it is quite chaotic because he moves his head rather than his eyes when reading.

As SW1 strengthens the muscles around his eyes and learns to move his eyes without moving his head these movements will become far more clearly defined.

Numbers Profile ReadAlyzer

	Left	Right
Fixations/100 numbers	183	183
Regressions/100 numbers	17	17
Fixation Duration (sec)	0.31	0.31
Rate (numbers/min)	104	

Saccadic differences >17ms = 0



SW1 was required to read numbers from left to right in lines laid out as text so that his eyes could be observed reading across text in small font with no meaning.

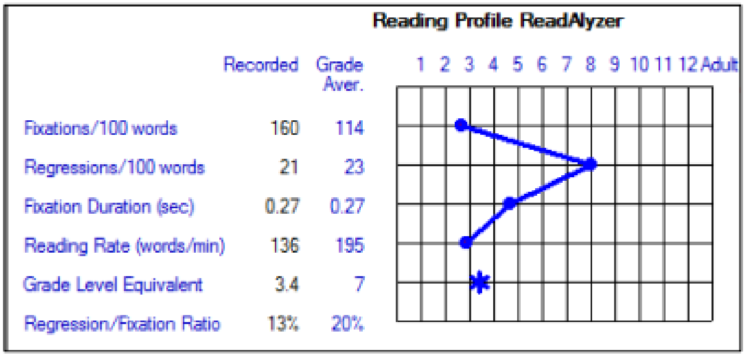
It is obvious from the data above and the screenshots to the left that SW1's eyes struggle to focus properly when reading small font text. He is only using one eye to read most of the time.

The visual dysregulation does highlight the need to exercise Henry's eye muscles so that SW1 can become skilled at adjusting his focus to work efficiently in the near range.

His eyes are not always working together, as can be seen. The eye tracker detected 0 occasion when the eyes moved separately with a timing difference of more than 17ms. This should not happen.

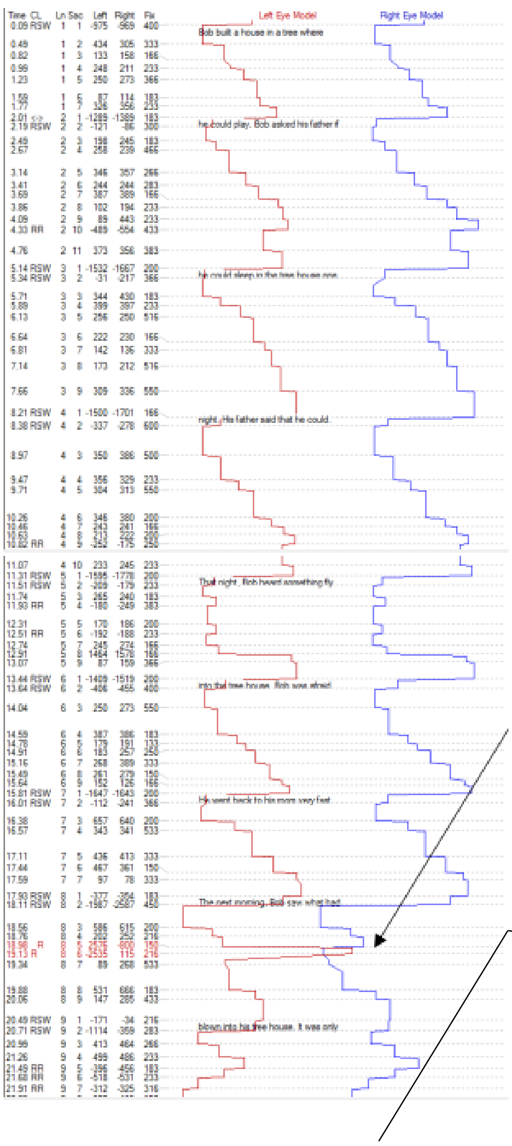
The eyes are struggling to work together, so in effect SW1 will be only using one eye. He will do this so that he can minimise disturbing flickering or doubling from his visual system to his brain.

The brain likes both eyes to work together to see and make sense of equal messages. SW1 currently does not have this skill when working in small font text.



Saccadic differences >17ms = 0; Comprehension = 9/10

Reading for meaning large font text



Reading for meaning test requires a person to read a short text and then to answer 10 comprehension questions at the end about the text.

In order to read a story for meaning a person needs to be able to combine sound and vision in order to make sense of the text. When there are problems with the task that will be reflected in dysregulated eye movements.

The data and the screenshots reflect two issues:

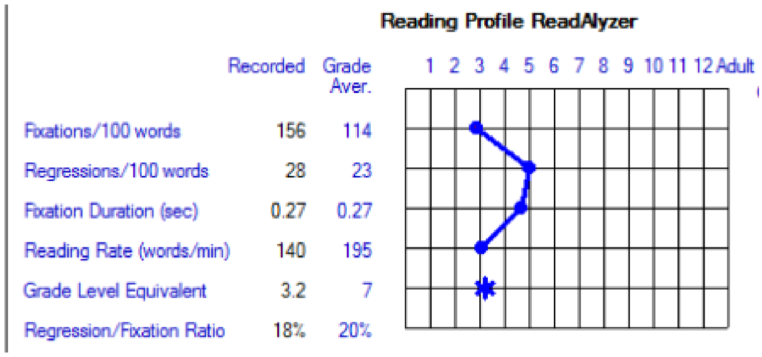
a) SW1's problems working with both eyes together;
b) SW1's problems with processing sound.

SW1 does not currently have the physiological development to read efficiently for meaning. He needs to address all his basic issues with motor skills, sound and visual control in order to become an efficient reader. His reading speed of 136wpm is too slow for his age. He is satisfactory in the time it takes him to focus his eyes on a section of text

0.28s; the target is 0.24s-0.27s. However, it can be observed that his eyes do make involuntary jumps.

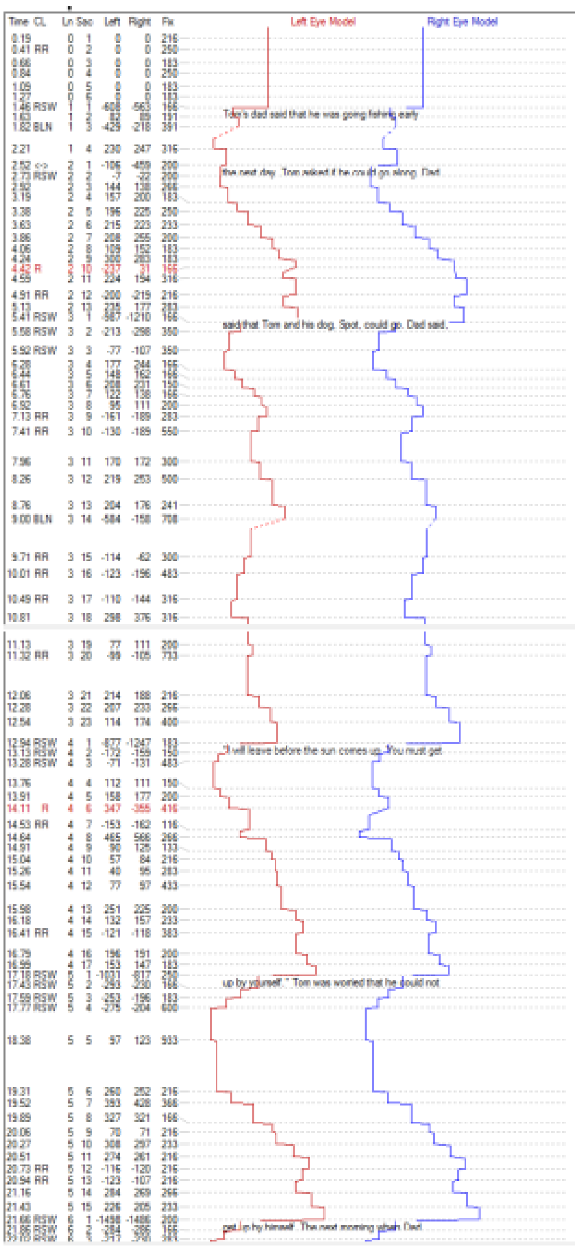
SW1's comprehension is good, but given the dysregulation of his eye movements, this will not be sustainable on more complex texts. As he encounters more complex texts he will struggle.

It will therefore be a good investment for life to ensure that SW1 can integrate his senses and motor skills in order to efficiently read for meaning.



Saccadic differences > 17ms = 0

Comprehension = 8/10



Reading for meaning

small font text

Reading for meaning test requires a person to read a short text and then to answer 10 comprehension questions at the end about the text.

In order to read a story for meaning a person needs to be able to combine sound and vision in order to make sense of the text. When there are problems with the task that will be reflected in dysregulated eye movements. SW1's eye movements are not that good when reading in small font, they are not working in a regular stepped pattern, but they are clearly trying to work together throughout.

The fixation duration of 0.27s, is satisfactory. But the reading speed of 140wpm is too slow.

The data and the screenshots reflect two issues:

a) SW1's problems working with both eyes together;

b) SW1's problems with processing sound.

SW1 does not currently have the physiological development to read efficiently for meaning. He needs to address all his basic issues with motor skills, sound and visual control in order to become an efficient reader.

SW1's comprehension is good, but he is reading at quite a low-level text. As he encounters more complex texts he will struggle. It will therefore be a good investment for life to ensure that SW1 can integrate his senses and motor skills in order to efficiently read for meaning.

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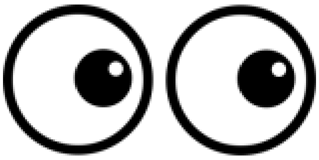
Vision Observations

SW1 does not have efficient binocular vision. It is not possible to establish it properly until his core strength and bi-lateral integration of motor skills work well.

SW1 needs to undertake basic eye exercises to strengthen the muscles around his eyes, in order to be able to establish binocular vision and eventually efficient visual processing. The following are recommended:

1. Learn to wink with both eyes;
2. Squeeze eyes tightly closed count to 10; open eyes very wide look around without moving head;
3.  Moves to the left and to the right x 10;
4. Move eyes up and down x 10;
5. Move eyes in circles clockwise x 5;
6. Move eyes in circles anti-clockwise x 5;
7. Imagine that there is a big clock in front of you…. look at the centre, then move eyes out to 1; then back to the centre; out to 2; then back to the centre and so on until 12;
8. Converge and diverge eyes whilst focusing on a pencil top and keeping the pencil top as one single image. Keep practising daily until able to bring the top to your nose without going into double vision.

Once primitive reflexes have been mastered move on to exercise 9

9. Crossing the mid-line do this exercise once the primitive reflexes are established: using two pots at about shoulder width apart, patch one eye. Pick up items from pot A with left hand, move in an arc at eye height across mid-line and place in pot B continue until pot A is empty; still using the left hand return the items in the same manner to pot A; repeat with the right hand.

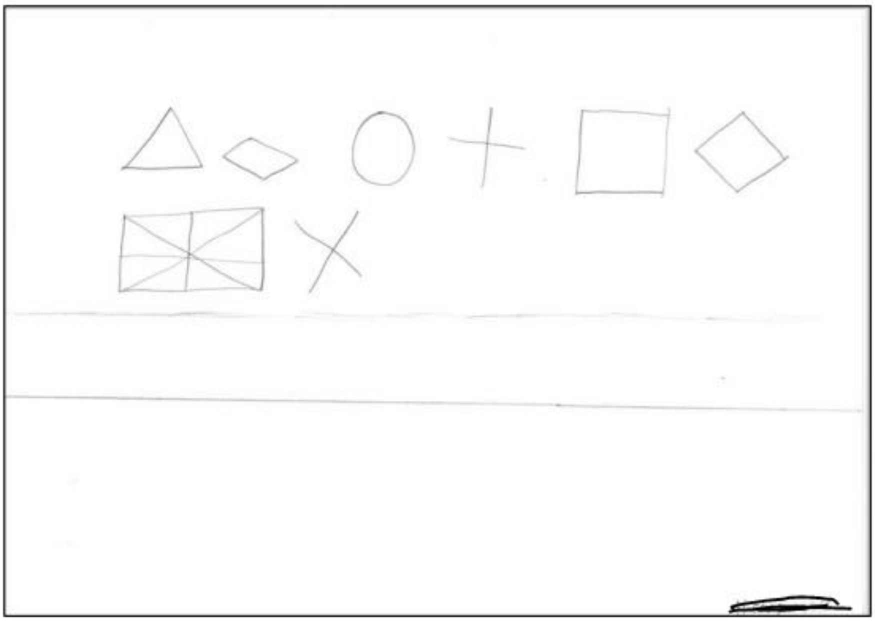
Patch the other eye and repeat. All the time that items are being moved from one pot to another the eye should be following the items.

10

Cognitive processing

Tansley figure ground test + drawing a line across the page

SW1 was asked to "draw a line across the page" he drew the line freehand to start and then with a ruler. In order to draw the line he worked with his right hand, he placed the paper to the right of his mid-line and then twisted his body and his head so that he could work with his left eye i.e. he did not cross his mid-line in order to complete the task. He rotated the paper and drew down from top to bottom. It is exhausting to work like this.



Note: There are specific ages at which a child would be expected to be able to reproduce each of the shapes based on the Tansley Standard Figures: circle clockwise = 3 years; circle counter- clockwise 5 years; cross = 3.25 years; square = 4 years; X = 4.5 – 5.5 years; triangle = 6 years; diamond = 7-7.5 years; Union Jack = 6 years. It is therefore possible to identify signs of immaturity if a person is unable to reproduce shapes which are commensurate with their age.

11

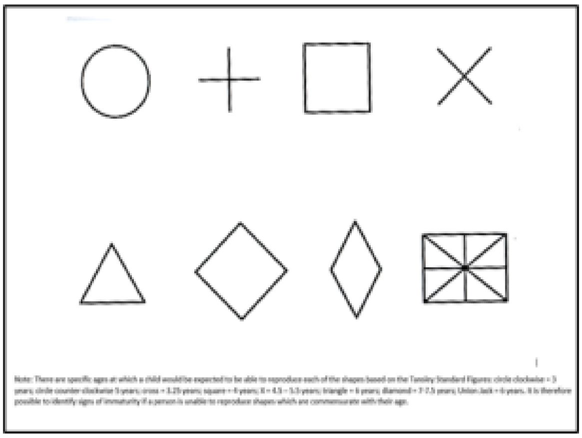
The ability to produce the shapes and the symmetry of the shapes is a good indication of how well SW1 works with left and right vision and motor skills to understand concepts as a whole. Lack of precision will slow down his work and make him anxious, he will know it is not quite right, but not how to correct it.

Observe how SW1 moves his body and the paper to avoid working across his mid-line.



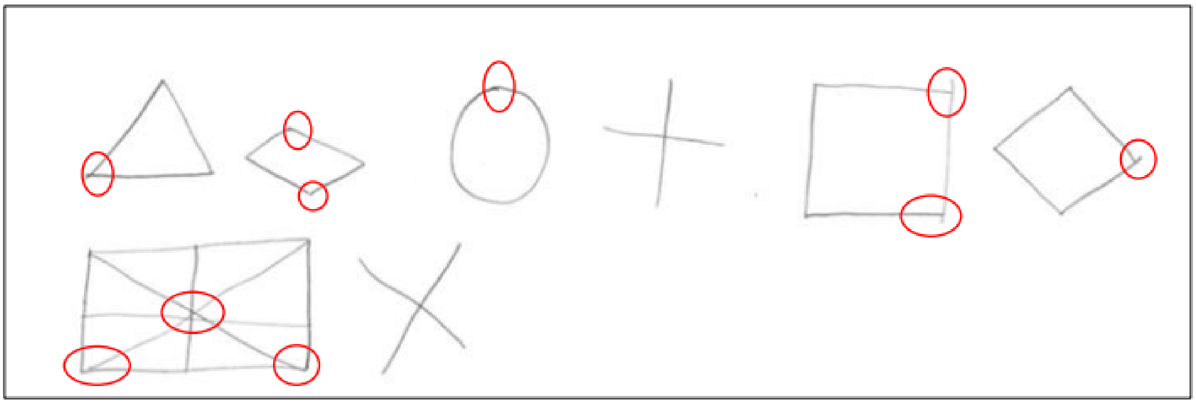

The strain of working with both left and right sides of his body and vision is so great that SW1 tightens his jaw to cope. This is an overflow gesture because left and right sides are not working well together.

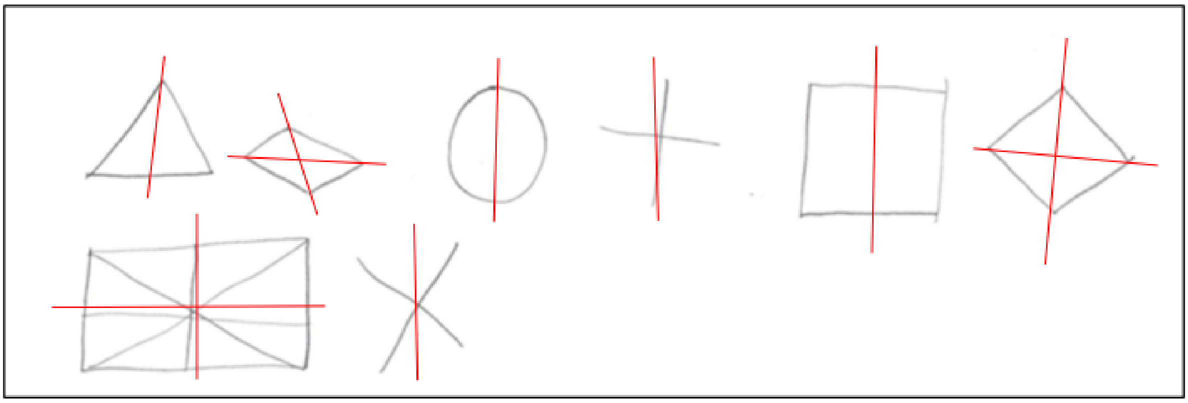


These are the shapes that henry was shown one at a time, compare these in detail to how SW1 reproduced these shapes. Below the circles indicate where SW1 struggles to understand where to start and stop drawing lines – his vision is not sharp enough, nor his sense of left and right. The lines highlight issues to do with symmetry of the images. SW1 knows there are problems, but he does his very best to complete the task.

SW1 is working very hard, but his senses make it impossible to produce a good result.





Making a jigsaw puzzle with no picture to copy

SW1 was given a scrambled 12-piece jigsaw puzzle and asked to make it. This is a useful exercise to show how SW1 operates to make sense of the world and how exhausting that process is.

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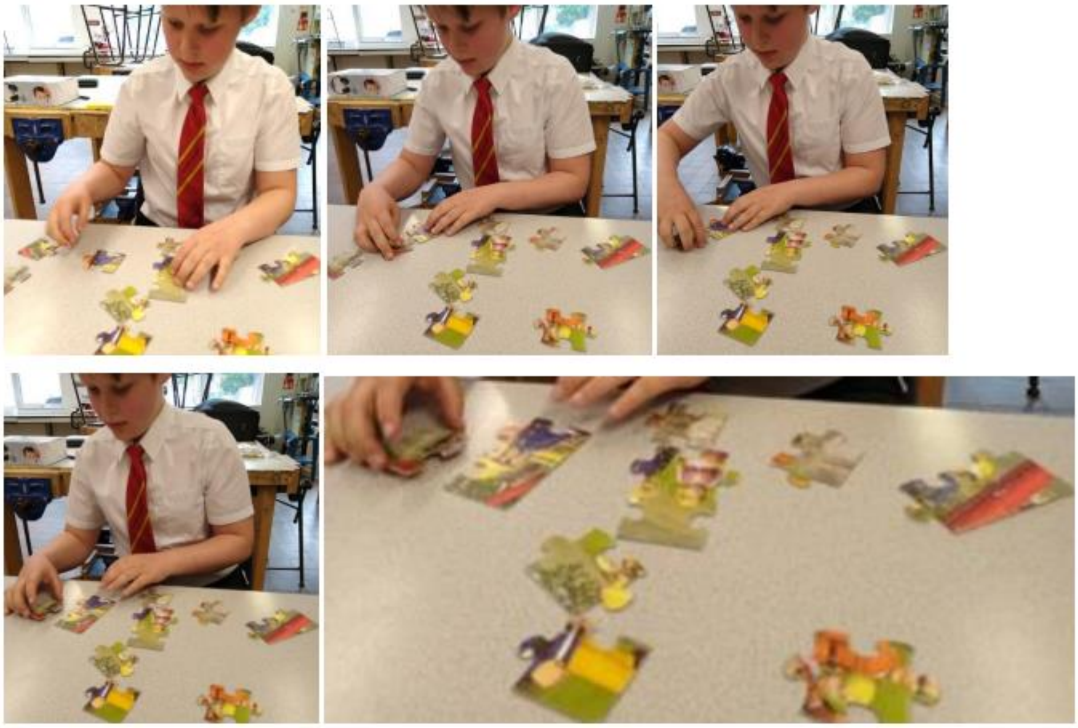
SW1 works with left hand on left side and right hand on right side, as far as possible he avoids crossing his mid-line. He pivots his body and head to avoid crossing his mid-line.

SW1 tries to match pieces by trial and error. He makes the puzzle in sections because he finds that easier. He cannot understand how the puzzle fits together at this stage.



SW1 alternates between working on his left side and his right side. He focuses on sections of the puzzle to try to match them but cannot at this stage see using his visual system how the whole puzzle fits together.

In order to move pieces from left to right SW1 pivots his whole body.

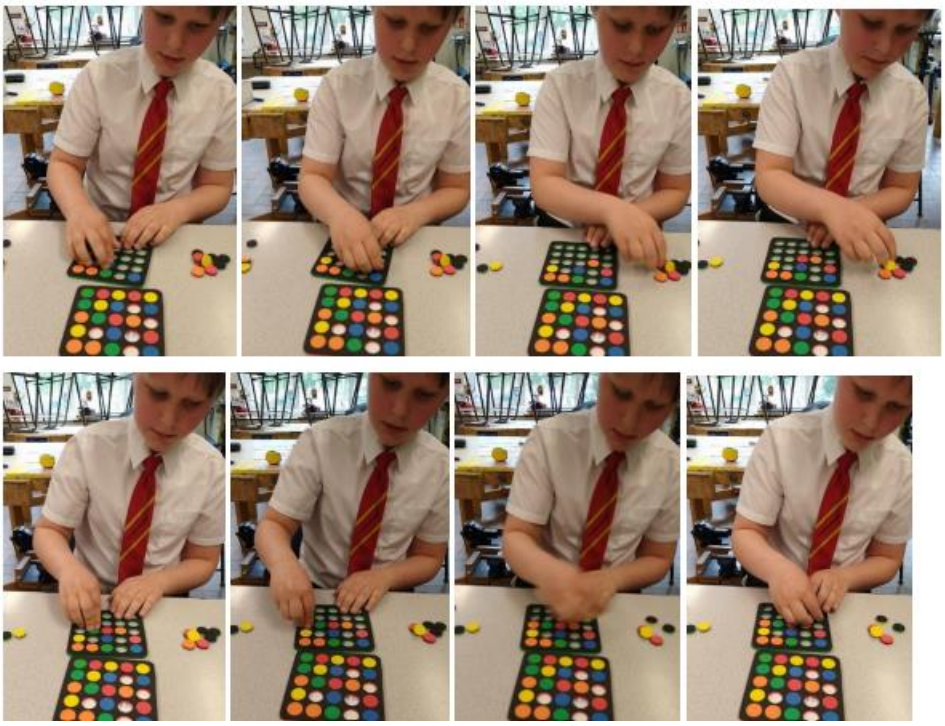
He uses touch to try to bring together sections of the puzzle. He tries to match the two sides of the puzzle, not thinking that there are other pieces in between. When that fails, he tries other pieces by trial and error. By this stage he is working on just the right side of his mid-line.

SW1 completes the puzzle working to the right of his mid-line, by trial and error. SW1 does not try to visually scan as he cannot use that skill until his eyes work together.

Copying a pattern

SW1 was asked to copy a pattern of coloured buttons. The buttons that he was to work with were placed on either side of the puzzle.

SW1 moves the mid-line of his body leaning to one side or the other to avoid mid-line crossing. He works predominantly with left hand on left side and right hand on right side. At times he prefers to hold his place with his left hand and lean over to the left so that his right hand does not actually cross his mid-line.



SW1's fingers hold the place and also help to work out the relative place of the pieces. SW1 works quite logically from left to right in rows top to bottom.

At times SW1 will pick up with the left hand and pass to the right hand at the mid-line. This enables him to use a piece with his right hand without leaning over to pick it up.

SW1 completes the puzzle quite well using coping strategies he would feel a lot more confident if he could use his visual system more efficiently and did not need to rely so much on touch.

Finding words in a jumble of Scrabble letters

SW1 was asked to look at the Scrabble letters, but not touch them and to identify as many words as possible that he could spell from the letters.

SW1 twisted slightly from side to side, eye to eye trying to make better sense of the challenge.

In order to do this task a person must be able to rotate letters in their mind's eye and so build up strings of words quickly such as: in; kin; gin; yin; king; again; cain; gain; and so on.

SW1 barely uses his visual system and even with coping strategies he finds this nearly an impossible task. He suggested three words: "Jake; nay; can".

Appendix Background Information

Notes on motor sensory integration "A considerable amount of cognitive processes depend on multisensory integration (MSI)" (Dionne-Dostie et al). MSI has not reached maturity in children younger than eight years old (Gorri et al ,Nardini et al) "Until the brain reaches about the age of 7, the brain is primarily a sensory processing machine. This means that it senses things and gets meaning directly from sensations. A young child doesn't have many abstract thoughts or ideas about things; he is concerned mainly with sensing them and moving his body in relation to those sensations. His adaptive responses are more muscular or motor than mental. Thus, the first 7 years of life are called the years of sensorimotor development." (Ayres, 2005).

Gross Motor Skill Development

Gross motor skill development is fundamental for:

a) suppression of primary reflexes in order to have basic muscle control;
b) bilateral integration and so make use of both arms to complete a task;
c) development of fine motor skills;
d) posture, in order to be able to hold the head in a manner that optimises the use and development of auditory and visual processing skills;
e) development of self-awareness, spatial awareness and orientation, and proprioception.

Tests are selected to assess whether the student has mastered working with both left and right sides of their body in a coordinated and fluid fashion in any direction, and that they have the core strength to support their head for a day at school.

Stages in Postural Control Development:

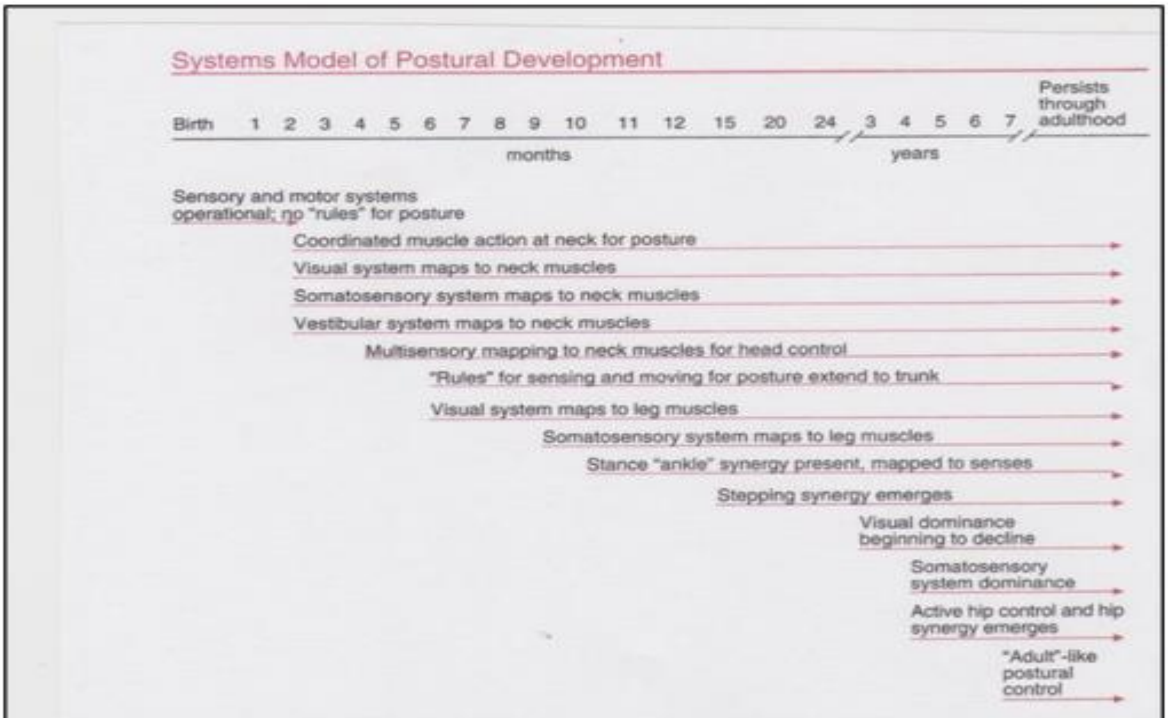


FIGURE 8.15 A systems model of postural development showing the emergence of critical stages in the develo

Auditory processing development - Background Information (Tomatis)

• **General Testing Procedure**

The student wears the Tomatis testing headset and a sound of a specific frequency is played at an increasing volume until the student signals that they have heard it. The frequency of the sound decreases in steps from 8,000Hz to 125Hz. Subjects are tested for sensitivity through both air conduction and bone conduction (through the skull), first with the left ear and then with the right.

• **Auditory Frequency**

Humans can generally hear sounds with frequencies between 20 Hz and 20,000 Hz (the audio range or hearing range) although this range varies significantly with age, hearing damage and gender. Most human speech communication takes place between 200 and 8,000 Hz. The human ear is most sensitive to frequencies around 1,000-3,500 Hz.

• **Auditory Volume**

Humans can hear in a range from 0 decibels (quieter than the sound level of rustling leaves) to 130dB (the threshold of pain). Noise at 85dB can cause permanent damage to the inner ear and cause hearing loss. A typical conversation occurs at 60dB.

• **Air Conduction Testing** - Blue Curve

In an ideal air conduction curve, the perception of sound starts at around 30dB for 125Hz, falls to 10dB at 1000Hz, and stays below 10dB until there is a slight rise in volume at the upper range (4,500Hz to 8,000Hz). Humans primarily hear using air conduction, rather than bone conduction.

• **Bone Conduction Testing** - Red Curve

An ideal bone conduction curve does not overlap with the air conduction curve and goes from 30dB at 250Hz to 20dB at 8,000Hz with most of the curve above (i.e. quieter than) 20dB.

• **Comparing Air and Bone Conduction**

The gap between air and bone conduction curves should be consistent throughout, with the air conduction (blue) curve above the bone conduction (red) curve. When there are overlaps between the air and bone conduction curves, it can indicate that a person struggles to manage stress and regulate their behaviour.

• **Laterality Testing**

The Tomatis assessment measures the balance between left and right ears and indicates which ear is dominant. Humans process speech more efficiently if they are right ear dominant. For this test, subjects listen to themselves counting into a microphone which they hear through headphones. The sound starts at 50 decibels in the left ear and 10 decibels in the right ear and the balance of the sound is slowly shifted from left to right until the volume is equal in both ears. It is then shifted further until the balance is 10 decibels in the left ear and 50 decibels in the right ear. Throughout the test the subject indicates on which side(s) they can hear the sound. The assessor records when the subject can hear the sound clearly in the right ear only, at which point the subject is said to have extracted themselves from the influence of the left ear.

The process is repeated starting with 50 decibels in the right ear and 10 decibels in the left ear and the assessor records when the subject can hear the sound clearly in the left ear only. At that point the subject is said to have resisted the influence of the right ear.

• **Specialisations Errors**

Specialisation errors occur when a person cannot identify the correct direction that a sound comes from; they recognise that there is a sound, but they think it is coming from the opposite side or are unable to identify where it is coming from. When there are significant spatialisation errors, messages to the brain are likely to be fragmented and there may be an impact on fluency of speech.

Development of sound processing skills

Table 3–1. Structural, Electrophysiological, and Behavioral Correlates in Maturation

Age	Structural	Electrophysiological	Behavioral
<6 mos	Layer I cortical axons are mature Acoustic radiation myelination starts	ABR wave I latency mature ABR waves III-V, MLR, P2 and MMR present but latencies are immature	Discrimination of (speech) sounds, detection of change
6 mos–5 yrs	Brainstem axons are mature Acoustic radiation myelination mature Axonal neurofilaments in cortical layers IV, V and VI mature Cortical synaptic density peaks	ABR, MLR, P2, N2, MMN, and T-complex are mature P1 present but latency immature	Onset and development of perceptual language and general auditory perception
5–12 yrs	Axonal neurofilaments in cortical layers II and III are mature Decrease in cortical synaptic density	P1 matures, N1 emerges but amplitude remains immature	Processing of masked and degraded speech improves
>12 yrs	Cortical axons are all mature Temporofrontal language-related nerve tracts mature	Asymptotic maturation of N1	Speech understanding in reverberation and background noise matures

Source: Handbook of Central Auditory Processing Disorder, Vol I, 2nd Edition, 2014

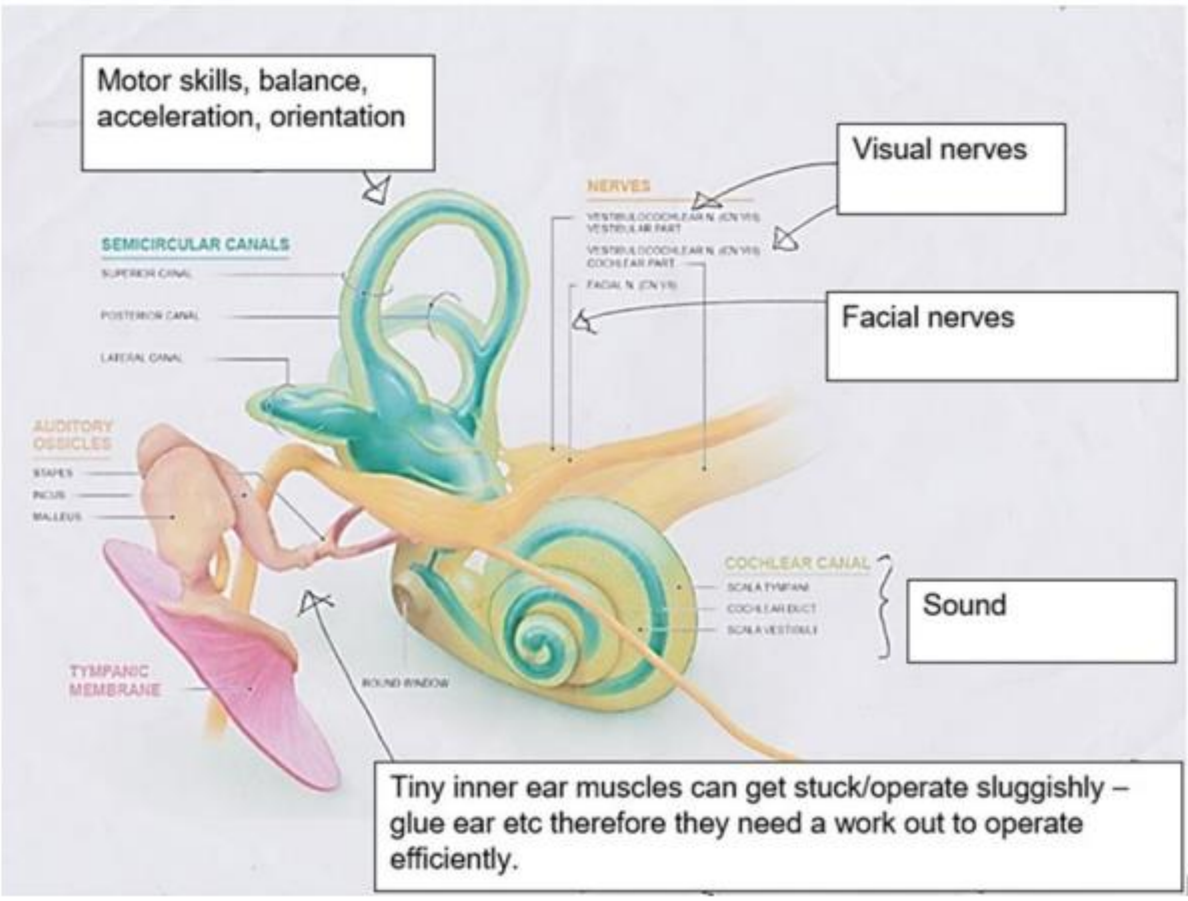
Most children master the following sounds at the following ages:

- around **3 years**: b, p, m, n, h, d, k, g, ng (sing), t, w, f, y
- around **4-5 years**: f, sh, zh, ch, j, s, and cluster sounds tw, kw, gl, bl
- around **6 years**: l, r, v, ng, and cluster sounds pl, kl, kr, fl, tr, st, dr, br, fr, gr, sn, sk, sw, sp, str, spl
- around **7-8 years**: th, z, and cluster sounds sm, sl, thr, skw, spr, skr

Phonological development: A normative study of British English-speaking children, Dodd et al (2003).

The Vestibular System

Image of the inner ear showing how the vestibular system brings together motor skills, sound, vision and facial muscles.



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Inner ear infection, according to Madaule (1997) Otitis media (inner ear infection) is the greatest cause of learning difficulties and auditory processing disorders. Acute otitis media (AOM) is the commonest paediatric bacterial infection, affecting up to 75% of children at some time before age 5 years (Klein 1994).

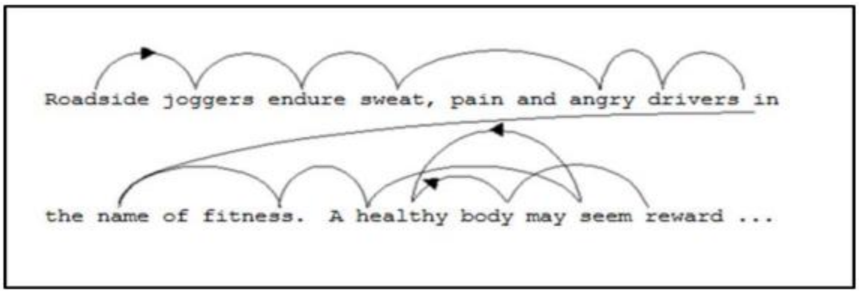
Hearing loss may persist well after the other symptoms have resolved, as 70% of children with otitis media still have middle ear effusion 2 weeks after onset, 40% at 1 month after onset, and 10% at 3 months after onset (American Academy of Family Physicians, American Academy of Otolaryngology-Head and Neck Surgery, American Academy of Paediatrics Subcommittee, 2004).

Visual Development

All children need to develop binocular vision in order to be efficient learners. Both eyes need to work together so that children can:

- learn how to fully use their cognitive visual skills, hence be able to "see" patterns and 3D, distinguish relevant from irrelevant information and read the world around them;
- track text smoothly with both eyes, hence read efficiently.

Eye movements



Definitions

- Forward movements of the eyes are called **saccades**; the purpose of these movements is to bring particular areas of text into the sharp central vision.
- The brief stops to focus on particular areas of text are called **fixations**.
- About 15% of the time, the eyes make movements back to material already read; these are called regressions**.**

Eyes should be always moving together. Analysis of vision seeks to identify when left eye and right eye are moving differently.

TABLE 2-1 ■ Developmental Trends in Reading Eye Movements

Grade	1	2	3	4	5	6	7	8	9	10	11	12	Collimation
Fixations (including regressions) per 100 words	224	174	155	139	129	120	114	109	105	101	96	94	90
Regressions per 100 words	52	40	35	31	28	25	23	21	20	19	18	17	15
Average span of recognition (in words)	0.45	0.57	0.65	0.72	0.78	0.83	0.88	0.92	0.95	0.99	1.04	1.06	1.11
Average duration of fixation (in seconds)	0.33	0.30	0.28	0.27	0.27	0.27	0.27	0.27	0.27	0.26	0.26	0.25	0.24
Rate with comprehension (in words per minute)	80	115	138	158	173	185	195	204	214	224	237	250	280

From Taylor EA. The fundamental reading skill. Springfield, IL: Charles C Thomas, 1966.