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PRIMARY eye care

Amblyopia - New Treatments Show Brain Plasticity is Alive and Well

New Zealand research leads to new amblyopia treatments for children and adults

Amblyopia is the most common cause of visual impairment among children in the developed world and, according the Auckland Medical Research Foundation, it affects approximately 155,000 (3%) people in New Zealand alone.

Conventional thinking has held that unless it is successfully treated in early childhood, amblyopia usually persists into adulthood.

Amblyopia is the general term used when the vision in one eye is reduced because the eye and the brain are not working together properly.

The eye itself looks normal and may be capable of functioning visually, but it is not being used normally because the brain is favouring the other eye. It is associated with either a strabismus (turned eye) or anisometropia (unequal refractive error) or both. (Hess et al, 2010)

Strabismus is often treated by surgical intervention to realign the misaligned eye. Non-surgical treatments for amblyopia include glasses, patching, and more recently the use of atropine drops.

Sometimes called lazy eye, amblyopia is actually more of a case of abnormal brain development. It is the mismatch of images streaming to the brain that leads to the visual areas of the brain processing only part of the information received.

In the past, treating amblyopia has been most successful in children younger than 7 years old, while their brains are still young. Mature brains were thought to lack the 'plasticity' or capacity for change that is needed to learn how to use the amblyopic eye effectively. (AMRF, 2014)

Methods of treatment are designed to force the child to use the eye with the weaker vision, helping part of the brain involved in vision to develop more clearly. (National Eye Institute) However, they have shown poor patient compliance in children due to discomfort and social stigma.

Fortunately, limitations to treating amblyopia could be significantly lessened as breakthroughs in research over the last few years present options for engaging treatments for both children and adults alike.

Binocular Treatment of Amblyopia using Video Games (BRAVO)

Dr Ben Thompson, of the University of Auckland, and his colleagues at Auckland University and at McGill University are leaders in developing new approaches to the treatment of amblyopia in both adults and children.

The international BRAVO trials investigated binocular treatment of amblyopia using video games. The treatment tested a different approach to patching and rather than forcing the subject to use their amblyopic eye the video game encouraged them to use their two eyes working together.

Optometry is so much more than selling glasses

The trial used specially modified video games, such as Tetris, that can only be played if the two eyes cooperate. There is also a version of the treatment that runs on an iPod touch device.

Initial studies into the video game treatment showed that the treatment not only improves vision in the amblyopic eye, but can also restore 3D depth perception. “In some cases, this was the first time that the patients had ever experience 3D vision,” says Dr Thompson. “In the longer term, current research into techniques that allow the adult brain to learn how to use an amblyopic eye may be applicable to a range of other neurological disorders that require skills to be relearned. I am working closely with colleagues within the Centre for Brain Research at the University of Auckland to advance this goal.” (Dr Ben Thompson via AMRF, 2014)

The other approaches developed for adults in Dr Thompson’s research, which is supported by the Auckland Medical Research Foundation, involve the application of safe, non-invasive brain stimulation techniques to the visual cortex and the combination of patching with Fluoxetine (Prozac) which has previously been found to reverse amblyopia in adult animals. (AMRF)

Dr Thompson says they “are currently investigating the combination of multiple treatment approaches to see whether even greater vision improvements can be achieved in adults with amblyopia.” The research not only aims to improve vision, but also seeks to provide new insights into the mechanisms that control plasticity in the human brain. Studying the visual system could lead to the development of new treatment techniques that could be applied to a range of different brain disorders. “I am very interested in understanding the brain mechanisms that allow for vision to be improved and I am using a variety of brain imaging techniques to address this question,” states Dr Thompson. “In addition, I am working closely with collages within the Department of Optometry and Vision Science, the Auckland Bioengineering Institute and the Liggins Institute on the development of new techniques for assessing vision in children that may allow for the early detection of vision and neurodevelopmental problems.”

The BRAVO trial got a lot of coverage in the international medical press and in March this year the French game developer, Ubisoft, and US optical technology company, Amblyotech, announced their collaboration on the development of Dig Rush, the first video game based on a patented method exclusively used for the treatment of Amblyopia.

The innovations patented by Drs. Robert Hess, Benjamin Thompson (Auckland University), Behzad Mansouri, Jeremy Cooperstock, Long To and Jeff Blum (McGill University)are licensed to Amblyotech, and Ubisoft is applying gameplay principles to create an entertaining method that can improve patients' engagement and experience during Amblyopia therapy.

Ubisoft and Amblyotech say that they have great hopes for the game approach because it avoids the necessity of an eyepatch, overcomes the issue of poor patient compliance due to discomfort and social stigmas, and has been tested clinically to significantly increase the visual acuity of both children and adults who suffer from amblyopia.

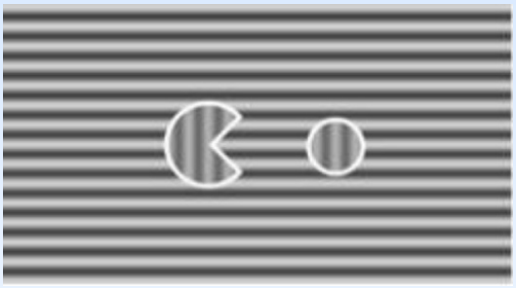
“The development of Dig Rush was a great opportunity for us to contribute our knowledge and skills in video game development to help materialize a breakthrough novel medical treatment.” said Mathieu Ferland, Senior Producer, Ubisoft. “The team from Ubisoft Montreal has been able to create a more engaging and enjoyable experience for patients being treated for Amblyopia, and we’re proud to be involved in such a positive illustration of the impact of video game technology.”

Resetting the Inter-ocular Inhibitory and Excitatory Balance with a Novel Video Game

Over in the USA, Dr Teng Leng Ooi and her team at Ohio State University have also now developed a video game strategy for treating amblyopia, to simultaneously strengthen the vision in the weak eye and suppress the vision in the other eye.

Dr Ooi describes current patching treatment methods as “push-only,” as the dominant eye remains unused, and one of the issues with patching is that it works when the dominant eye is covered but as soon as it is uncovered the dominant eye tends take over again. The new development is described as a “push-pull” method that makes both eyes work together.

The Ohio game is like a simplified Pacman clone and, combined with optical illusions, aims to teach the brain to make both eyes work together, rather than using traditional patching methods which teach the brain to focus on the weak eye only when it has to.



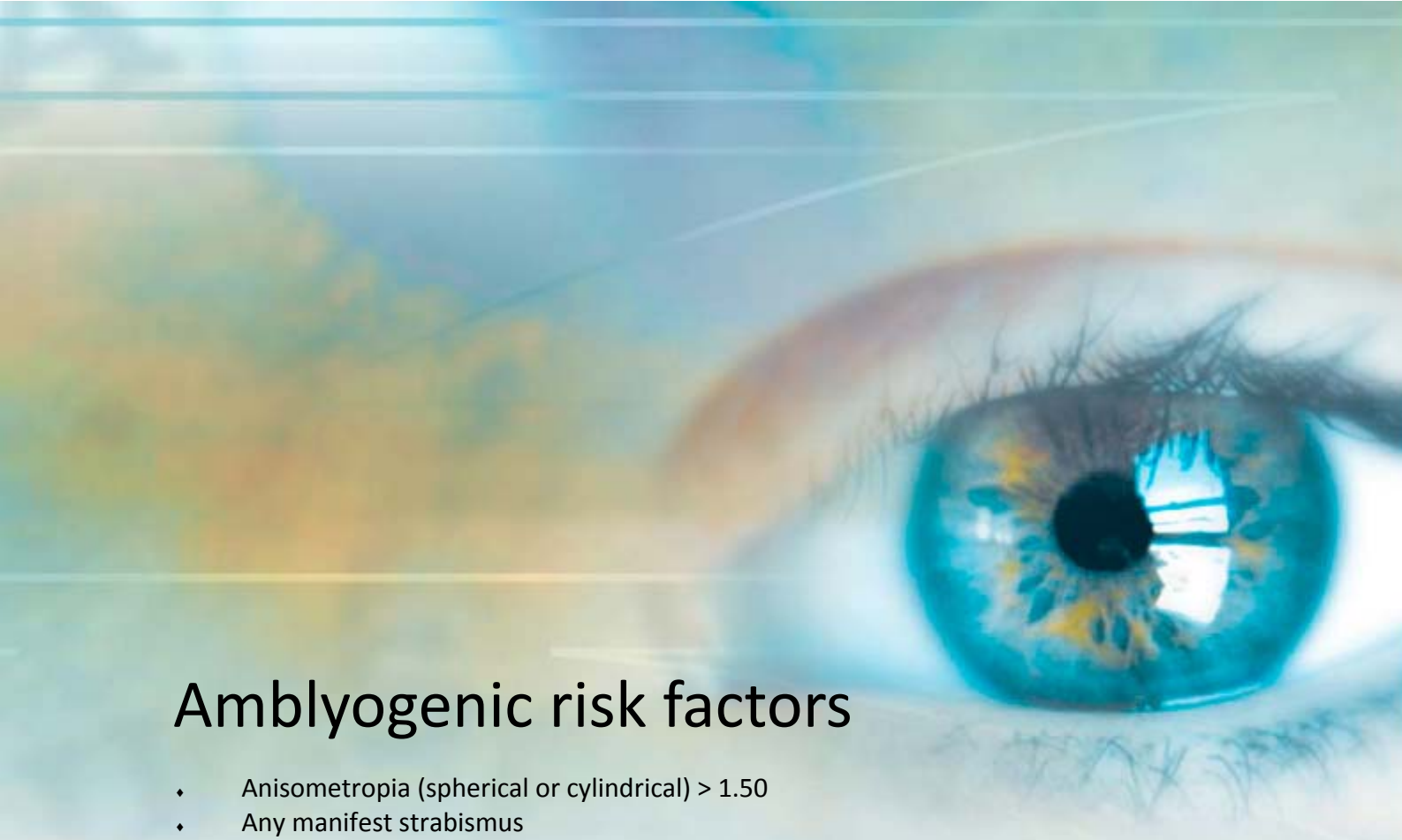
Ooi’s research was conducted over a 10-month period, during which participants went through four phases:

- a pre-training test,
- training with the video games,
- a post-training test and
- a retention test.

Depending on the severity of the lazy eye, participants attended between 15 to 30 sessions in the training phase.

Ooi and her team studied the complex brain network involving both the excitatory and inhibitory signals between the two eyes. When properly balanced, these signals govern binocular vision and produce 3D depth perception in the eyes. When an imbalance exists, a person will have sensory eye dominance.

The study found that the games reduced sensory eye dominance and improved depth perception in adult subjects with lazy eye and in those with normal vision. The games also resulted in an improvement in the sharpness of vision in the lazy eyes.



Amblyogenic risk factors

- Anisometropia (spherical or cylindrical) > 1.50
- Any manifest strabismus
- Hyperopia > 3.50 D in any meridian
- Any media opacity > 1 mm in size
- Astigmatism > 1.5 D at 90° or 180° in oblique axis (>10° eccentric to 90° or 180°)
- Ptosis ≤ 1 mm margin reflex distance (the distance from the corneal light reflex to the upper lid margin; a standard objective measurement of ptosis)
- Visual acuity per age-appropriate standards

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