Nystagmus and the fourth dimension

John Sanders and vision scientist Professor Chris Harris look at the causes and effects of the "slow-to-see" phenomenon in nystagmus

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People often think of vision impairment in terms of poor distance vision or problems with visual fields – but time can be a factor too. People with good vision will know that it takes longer to recognise someone in the distance, or read small text. For people with nystagmus the time needed to see is even longer. Put simply, people who have nystagmus, like myself, need more time to see than people with ordinary vision – even when objects or people are within our (generally limited) visual range.

What is nystagmus?

In nystagmus, the eyes move involuntarily, usually from side to side, but sometimes up and down or even with a rotating movement. There is often a "null point" in a person's vision, where the eye wobble is at its smallest. They may find it easier to see with their head held at an angle that allows them to use their null point.

It may help to explain what the slow-to-see phenomenon is not. It does not necessarily mean there are complete blanks in our visual field, although there may be, especially away from the null point. Mainly, being slow-to-see means we need more time to process the details of our surroundings or what we're looking at. So, given enough time we can see more, although rarely do people with nystagmus see as much as people with ordinary vision.

The relationship of eye and brain

Exactly why people with nystagmus take longer to see is, says neuroscientist Professor Chris Harris of the University of Plymouth,

probably more complex than people realise. He tells Insight: "Although the eye is often compared to a camera, it is a misleading over-simplification."

He goes on to explain that the optics of the eyes (the cornea, and lens etc) form an image on the retina, which is the light sensitive part at the back of the eye. In the retina there is a sheet of rod and cone photoreceptor cells that converts light into electrical signals, which is then sent to the brain via the optic nerves.

Cone cells are important for daytime vision and rods for night vision. How well you see in terms of resolution depends on the density of photoreceptors at each point in the retina.

"However, unlike a camera film, the resolution changes across the retina. In each eye, there is a special region in the retina called the fovea which has the highest density of cone photoreceptors, " says Chris.

"In order to look at a small object, it is essential to line up the fovea with the object. To do this requires first moving the eyes to line up with object, and then to hold the eyes still to keep the foveas steady and aligned with the object. Therefore, people with nystagmus have an obvious problem because the eyes are wobbling, so the fovea is not held steady."

Movement: of eyes, head and objects

A number of factors can affect the “time to see”. First, to look at an object that is not straight ahead requires an eye movement, which is why people move their eyes during reading. Sometimes if the movement is large, a head movement is also required. Even in people with normal vision, these movements take some time: from one fifth to half a second or more. This may not seem much, but typically we all move our eyes about three times a second, so the time spent moving the eyes really adds up. Altogether we spend about two hours a day making eye movements!

For people with nystagmus, these movements are less accurate and it takes longer to bring the foveas onto the target. So, in scenarios where there are lots of things to look at such as traffic and crowds, people with nystagmus take much longer to see the individual objects.

Delayed recognition

Even when the object is steadily imaged on the fovea, it still takes time for the brain to make a “decision”. Recognising an object can take up to a few seconds. For example, when you look down the eye chart, you must decide what each letter is. As the letters get really small it takes you more time to decide: this is basically because of the way brains work. Moreover, if the contrast of the letter is low, it takes even longer to decide.

Impact on vision

People with nystagmus have two problems. First, they often have an underlying visual problem such as albinism which means contrast for them is always lower, so it takes them longer than normal to make a decision. Second, because the eyes are wobbling, for much of the time the letter is not on the fovea – so it takes even longer to make a decision.

Effects of stress

There is also the problem of stress and anxiety. When people with nystagmus become stressed, their nystagmus gets worse. This in turn means that moving the eyes is less accurate, and the time when the fovea is aligned with the object decreases. Overall, this means it takes additional time to align the foveas and make decisions. We do not yet understand why stress changes the nystagmus, other than it is an emotional response affecting the eye movement circuits in the brain. However, it means for example that visual tasks under time-pressure (such as crossing the road) lead to stress and further increase the time to see.

Evidence and research

The anecdotal evidence for the "slow-to-see" phenomenon is strong and is increasingly supported by science. Researchers are now starting to investigate the relationship between time and nystagmus, and some of the questions it raises. For example, how much longer on average do people with nystagmus take to see? Does it differ much from one person to another? And most important of all, what is the impact of time on the functional vision of people with nystagmus?

Understanding students with nystagmus

Nystagmus is the most common form of visual impairment among school age children – at least that's what teachers of the visually impaired repeatedly tell Nystagmus network.

It's worth mentioning the danger of placing too much emphasis on visual acuity measures when assessing children with nystagmus. People with nystagmus often have comparatively good visual acuity (6/9 to 6/15 is not uncommon). But the visual acuity test is static and basic. It does not capture aspects of nystagmus such as variability, direction of gaze problems and of course the question of time. For teachers assessing the overall functional vision of children with nystagmus, there are as yet no reliable tools to measure the effect of "slow-to-see" and teachers will probably have to rely on their judgment based on long term observation.

In the classroom

In the classroom we may need more time to see things on the board – even if we're close enough by visual acuity standards. One of the banes of my schooldays was teachers rolling up the blackboard before I'd finished copying from it.

Very probably linked to the slow-to-see phenomenon is the problem people with nystagmus have with scanning. That covers everything from scanning a piece of text for a particular phrase or word, to scanning a group of people to find a friend.

Specialist teachers of the visually impaired in the north-east told me recently that children with nystagmus find it difficult to scan text, documents and screens. Some struggle to scan at all, while most are slower and less successful at scanning than their peers with ordinary vision. Highlighters, typoscopes, rulers, fingers on the page all help, but don't make up for the absence or near absence of the ability to scan.

In the playground

Being slow-to-see can add to the risk of children with nystagmus being isolated at playtime as it is harder for them to locate familiar faces. It will also increase the likelihood of them being left out of games and sports. This is especially true of fast moving ball games where most adults with nystagmus have painful memories of being the last one to be picked for teams at school or even left out altogether.

Taking longer to see inevitably means our reactions are slower, so it's not uncommon for children with nystagmus to be hit in the face by a ball or other object when most children would duck or catch it. In fact, many sports depend on being able to use your eyes to track a moving ball, and researchers at the Cardiff University Research Unit for Nystagmus (RUN) are currently investigating this ability in adults as well as children with nystagmus.

To help a child take part in ball sports you can try brightly coloured balls or larger balls. The game may need to be adapted to include children with nystagmus who have slower reaction speeds than their peers.

Movement and traffic safety

It's possible for someone with nystagmus to look at a car and not see it. Or we may see a car, but not know whether it's moving or stationary, or its speed and direction.

This clearly has safety implications for decisions about crossing the road. Dr. Jonathan Erichsen (Director of RUN in Cardiff) hopes

that his team’s studies will provide a better understanding about general motion perception in those with nystagmus.

Communication

The slow-to-see issue is particularly confusing in the context of communication. Not being able to see with the same agility as others can lead to misunderstandings and confusion. We might, for example, fail to spot a brief smile, nod of the head or hand gesture, even when we’re a metre or less away from someone. If teachers and fellow students are aware that we may miss such non-verbal cues, we can avoid unfortunate consequences and make life easier for students and teachers alike.

In the education setting, we hear of children not seeing speakers at assemblies, not seeing menus in the canteen and having trouble seeing on school outings because unfamiliar surroundings put more pressure on vision.

This risk of missing out on social and educational opportunities is due to many factors in the vision of children with nystagmus, such as poor distance vision, limited fields of vision due to the null point, variability and light sensitivity. But when supporting children and young people who have nystagmus, please keep in mind the effects of the slow-to-see phenomenon as well.

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