

Collecting Normative Data for Gaze Testing using Videonystagmography: Outcomes and Lessons from Practice

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Introduction

Videonystagmography (VNG) is used to measure eye movements including involuntary movements known as nystagmus as part of a vestibular test battery. One of the tests is gaze testing which measures the ability to maintain steady gaze on a stationary target at various angles and can identify peripheral and central vestibular disorders. The British Society of Audiology (BSA) recommends collecting departmental normative data for the VNG test battery as there is a lack of published normative data, with many based upon older technology, Electronystagmography (ENG) instead.

Study Aims:

- To establish normative data for gaze testing in the North Wales population using current equipment.
- To compare normative data collected to ENG threshold (6°/s).
- To compare new normative data to previously collected local normative value (3°/s).



Image from Interacoustics of VNG equipment.

Methods

Data was collected from a sample of healthy participants with no prior history of dizziness or vestibular disorder and who met the strict inclusion criteria.

- Equipment:** Interacoustics VisualEyes525 VNG
- Gaze positions:** target positioned in centre, right (30°), left (30°), up (20°) and down (20°) with and without visual fixation.
- Recording:** Maximum of 30 seconds to minimise risk of fatigue. Slow phase velocity (SPV) of nystagmus was measured in degrees per second (°/s) as seen in Figure 1 and Figure 2. The software was unable to measure nystagmus that was less than 1°/s.
- Participants:** 60 were included in the study (M21:F38:NB1, age 20-79 years, $\bar{x}$ = 42.8 (SD = 17.0)).
- Mental alerting used throughout**, similar to what has been used in other studies and following BSA guidelines.
- Exclusion criteria:** Exclusion criteria included things that are known to affect vestibular testing including centrally acting medications, alcohol within the last 48 hours of testing and eye movement disorders.

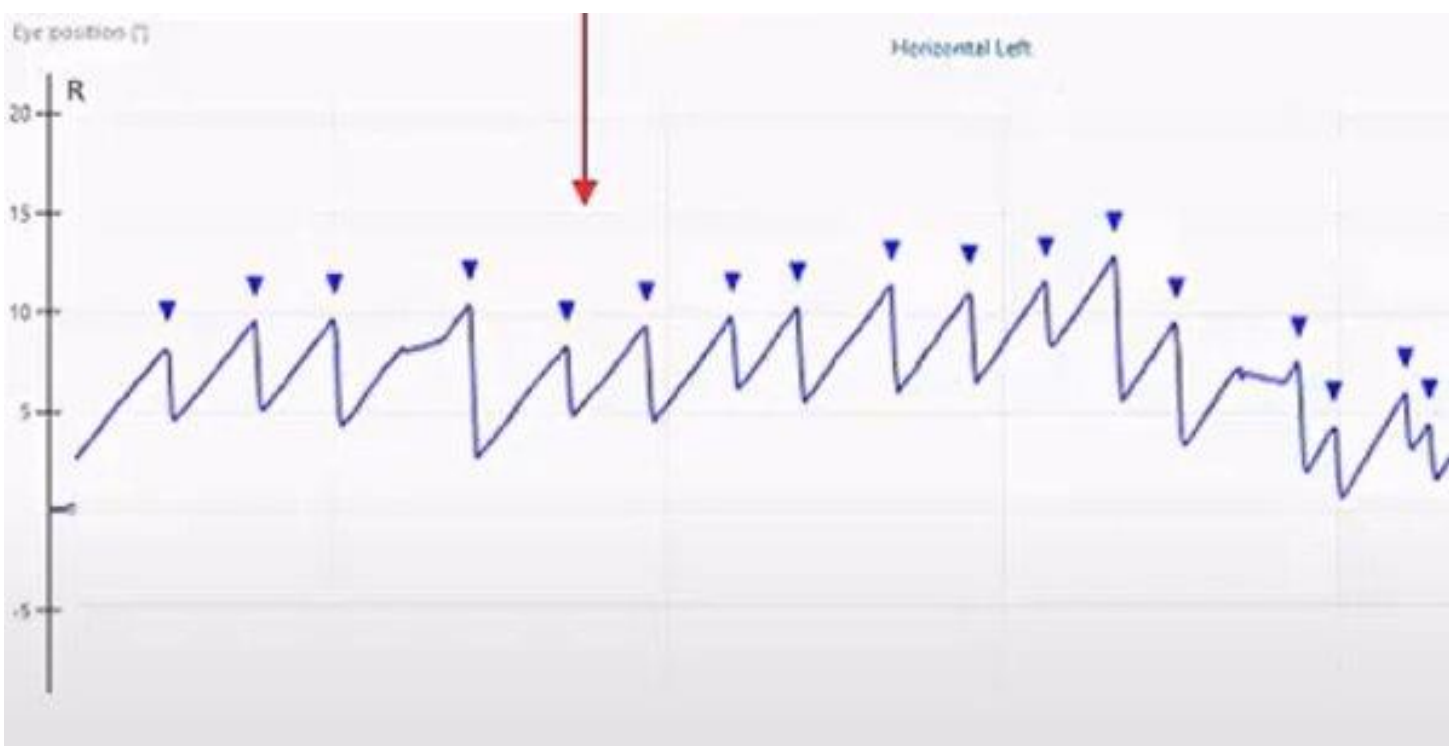


Figure 1: Nystagmus identified by the VNG software. Image from Interacoustics.

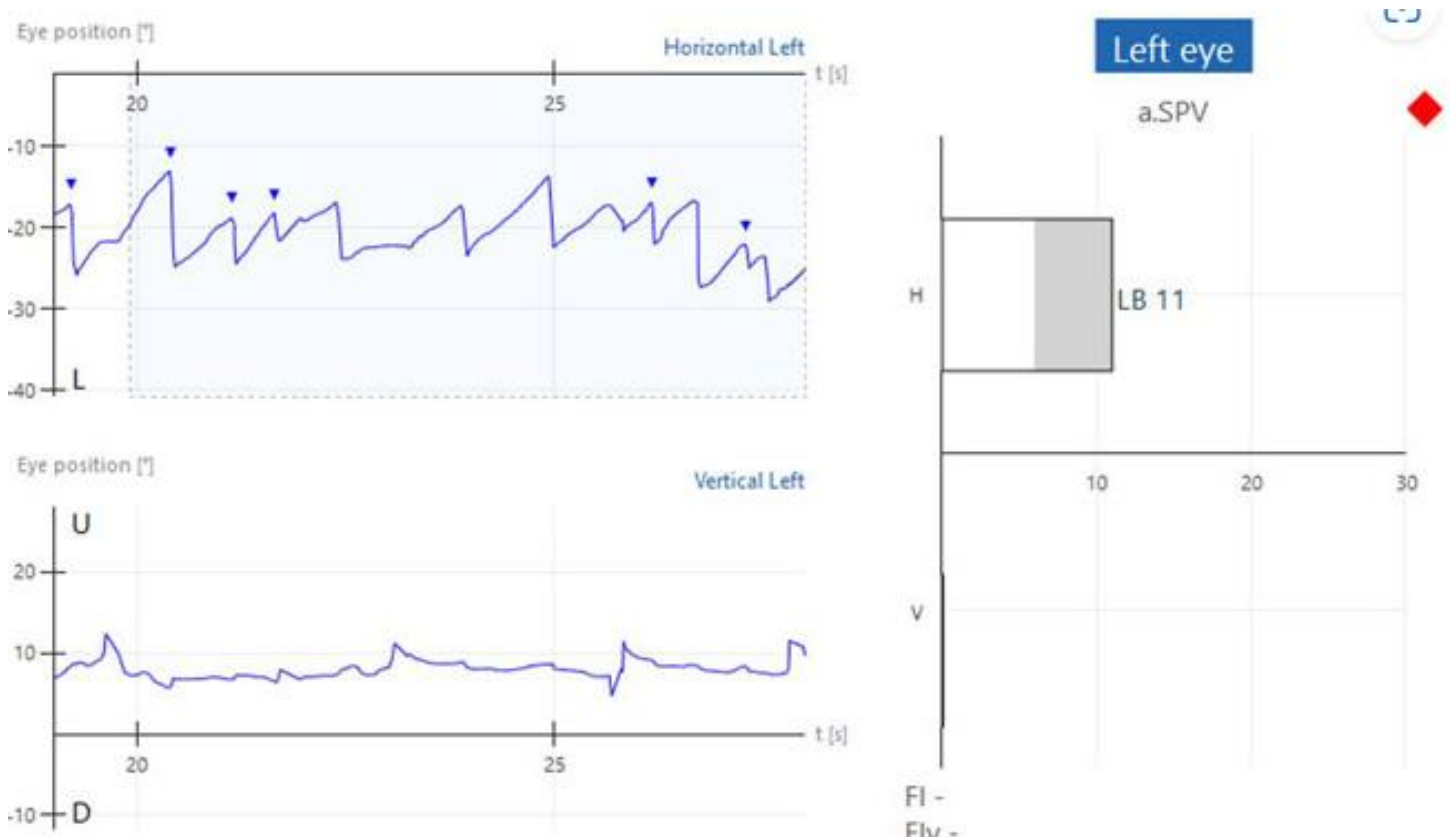


Figure 2: Nystagmus identified by the software and the average SPV (°/s) shown. Image from Interacoustics.

Literature Review

Research has shown that normal individuals can display a low level of non-pathological nystagmus without visual fixation. Normative data is used to compare with patient test results to identify abnormal results. The nystagmus intensity (i.e. SPV) is the characteristic used to differentiate between normal and abnormal nystagmus (Barin, 2006).

Normative data is defined as "Data that characterise what is usual in a defined population at a specific point or period of time" (O'Connor, 1990).

Current normative data including the Interacoustics VisualEyes system, use the normal cut off values of 6°/s from Barber and Stockwell (1980). This value comes from ENG and few studies have looked at gaze testing using VNG. It is thought that VNG can detect smaller nystagmus than ENG as the traces are cleaner. One study by Kang and Kim, (2015) found that a higher number of nystagmus beats were recorded in their healthy VNG group compared to ENG.

A study by Rogers et al. (2014) using the Chartr VNG system suggested a threshold of 3°/s or above as being abnormal for horizontal nystagmus, but vertical nystagmus was not included in this study.

Some authors consider that any vertical nystagmus seen with visual fixation removed to be abnormal (Jacobson et al., 2021), while others suggest that there may be a normal threshold (Mekki, 2013). BSA procedure recommends including vertical gaze testing in the VNG testing protocol if vertical nystagmus is seen during horizontal gaze testing, however there are currently no accepted normative thresholds for vertical nystagmus without fixation.

It is unknown whether there is an age effect on gaze testing. Rogers et al. (2014) found no significant difference in the results of three age groups. Conversely, Geisler et al. (2000) found that there was a higher prevalence of gaze evoked nystagmus in older adults however this was based on a very small sample.

Results

The data was skewed in our study, with most participants showing zero nystagmus (Figure 3).

No nystagmus was recorded in any gaze position with visual fixation.

Without visual fixation:

- 24 participants (40%) had nystagmus in at least one gaze position.
- Nystagmus intensities ranged from 0-6°/s, with a low total mean SPV for nystagmus in all test positions (0.27°/s, SD = 0.83), and a median of 0°/s when considering all participants.
- The mean SPV recorded in the 24 participants who had nystagmus was 2.13°/s (SD = 1.20) with a median of 2°/s.
- Horizontal nystagmus was more common than vertical:
 - 18 participants horizontal nystagmus (LBN = 45.8%, RBN = 45.8%),
 - 6 participants vertical nystagmus (UBN = 16.7%, DBN = 12.5%).
- Wilcoxon-signed rank found a statistically significant difference between the suggested 6°/s threshold and the data collected in this study for each of the gaze positions; Centre (z = -7.34 p = <.001), Right (z = -7.20 p = <.001), Left (z = -7.23 p = <.001), Up (z = -7.43 p = <.001), Down (z = -7.57 p = <.001).
- Wilcoxon signed-rank test indicated that SPV of nystagmus in this study was significantly different to the normative cut off value of 3°/s used within the department in all test positions, Centre (z = -4.59 p = <.001), Right (z = -6.97 p = <.001), Left (z = -7.07 p = <.001), Up (z = -5.11 p = <.001), Down (z = -7.05 p = <.001).

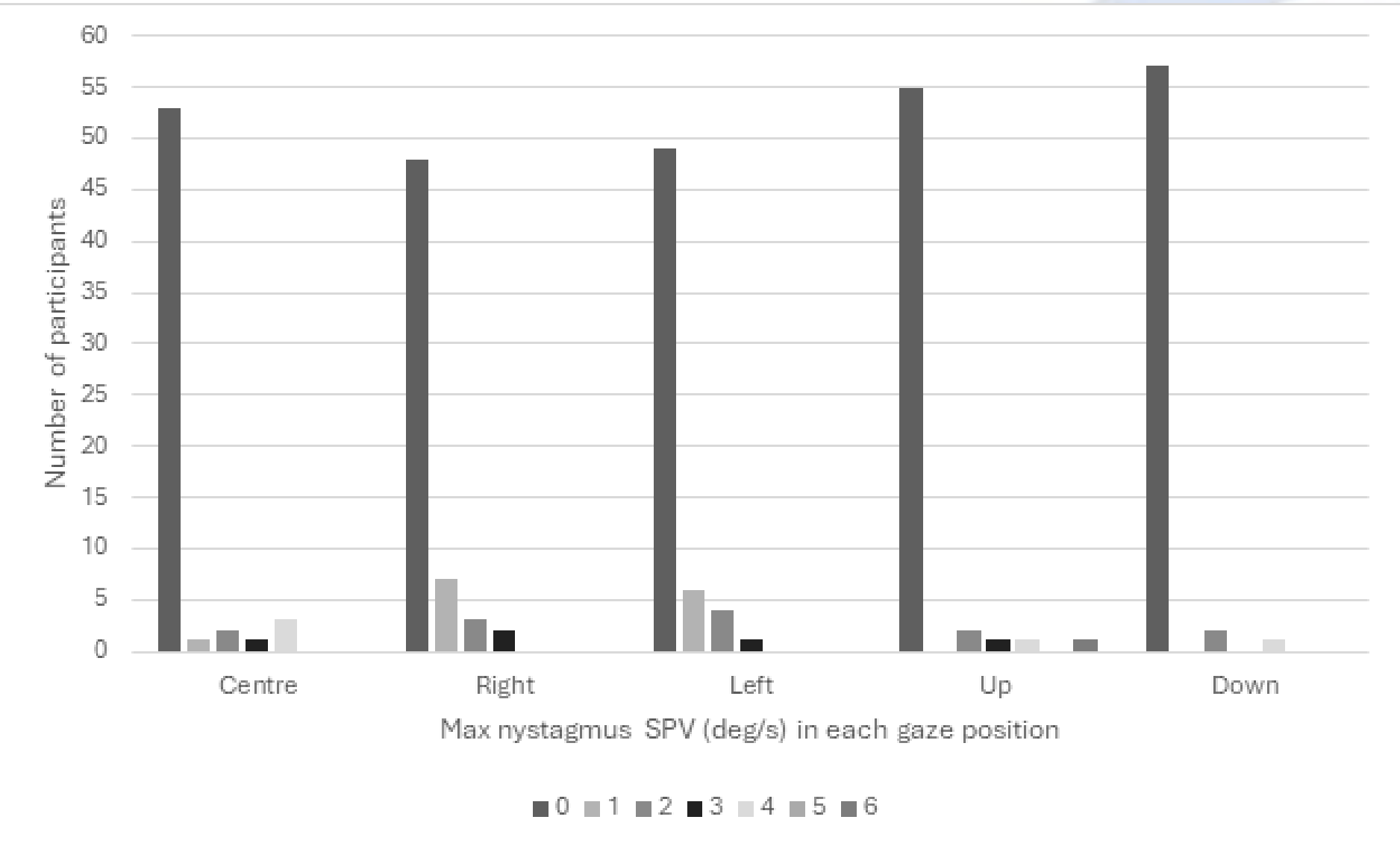


Figure 3: Nystagmus SPV (°/s) recorded in each gaze position without fixation.

Discussion

Due to time constraints on data collection, we were unable to recruit a larger sample of participants. However, with the data that was collected we have been able to observe the characteristics of nystagmus in normal individuals for this test and compare to other studies and to current normative values used by a manufacturer of VNG equipment and the local department.

Main points:

- Nystagmus is seen in normals when fixation is removed. Intensities recorded were similar to those seen in other VNG studies, and lower than those suggested from ENG studies, supporting the need for normative data using VNG.
- Initially aimed to compare between age groups but we were unable to recruit enough participants within the time frame, with more difficulty recruiting participants to the older age group who met the criteria.
- Due to the skewed data, it may not be appropriate to use the total mean value for all participants for this study to decide on a normative threshold. However, it is interesting to note that other studies have used the mean as their main value when considering a normal limit (Levo et al., 2004).

Learnings from Practice and Recommendations

Lessons were learnt regarding the practicalities of undertaking large normative data collection studies. Challenges included calculating sample size for a normative sample, recruiting enough participants who met the inclusion criteria, particularly from the older population, limitations of equipment and management of skewed data.

Further research is required to establish the normative data for VNG testing including studies collecting data from different locations to get a variety of populations and using a variety of VNG equipment to ensure that data is valid and appropriate for use across clinics.

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