Original Article

# Study of anxiety in patients with glaucoma undergoing standard automated perimetry and optical coherence tomography - A prospective comparative study

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**Purpose:** To compare the anxiety levels related to visual field testing and optical coherence tomography (OCT) in patients with glaucoma. **Methods:** This prospective, comparative study was conducted on patients with glaucoma. The participants' anxiety traits were assessed using the State-Trait Anxiety Inventory [STAI]. Before visual field testing on Humphrey visual field analyzer (HVF) and retinal nerve fiber analysis on OCT, the participants completed Form Y1 to measure the current pretest level or 'State' anxiety [pretest anxiety]. Immediately after testing, participants were administered the Form Y1 questionnaire to assess the induced anxiety level during the testing [Intratest anxiety]. **Results:** A total of 228 patients were enrolled with 152 participants in the HVF group and 76 in the OCT group. The mean age of the participants in the HVF group was 57.2 ± 20.8 years and in the OCT group was 56.8 ± 20 years. There was no significant difference in trait and pretest anxiety between the HVF group and the OCT group ($P = 0.971$ and $P = 0.716$). Intratest test anxiety score was slightly higher in the HVF group (HVF: 42.13 ± 10.63, OCT: 40.71 ± 9.76; $P = 0.33$). The anxiety scores were higher when the experience of previous HVF tests was <2 and least when the number of tests exceeded five. **Conclusion:** Automated perimetry induces slightly more anxiety than OCT, which may affect test performance. The measured anxiety reduces as patients gain familiarity with the test with experience. This adds credence to the recommendation of more frequent visual field testing in newly diagnosed glaucoma patients.

**Key words:** Anxiety, glaucoma, optical coherence tomography (OCT), State-Trait Anxiety Inventory [STAI], visual field testing

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Glaucoma is a chronic progressive neuropathy causing damage to the retinal ganglion cells and their axons resulting in optic nerve cupping with characteristic field changes. It is the second most common cause of blindness affecting middle-aged and elderly populations worldwide. Diagnosis of glaucoma is made after optic disk visualization, intraocular pressure measurement, and examination of field defects using automated perimetry and optical coherence tomography to quantify the structural changes in the retina and optic nerve.[1]

Standard automated perimetry is regarded as the gold standard for measuring visual fields. It uses light stimuli of different sensitivities at various locations in the visual field. The patient is asked to fix at the central point and click the button whenever a stimulus is detected.[2] This test is repeated twice or thrice for assessment of baseline as there is improvement in the test performance because of the 'learning effect'.[3] It is the only functional method to diagnose patients with glaucoma and monitor them for progression.[4] The most popular automated static perimetry test is the Humphrey visual field analyzer (HFA3, Carl Zeiss Meditec, Dublin, CA, USA, hereafter, HVF). The HVF is equipped with reliability indices for fixation loss, false-negative errors, and false-positive errors.

Optical coherence tomography (OCT) helps in the structural assessment of ocular microstructures, thereby, providing high-resolution visualization. It also provides an objective quantification of tissue thickness and change.[5] This imaging technology has also become an integral part of clinical glaucoma practice like automated perimetry. But unlike the visual field testing, it requires minimal patient participation.

Performance of automated perimetry and OCT requires co-operation from the patients with the visual field analysis also needing concentration. Previous reports have shown that visual field testing is rated as one of the least patient-friendly clinical tests in the management of glaucoma.[6-8] One of the major factors affecting the performance of these tests is anxiety. Hence, recognition of anxiety during field testing should be addressed to enhance test reliability. It is crucial that accurate and reliable results are obtained during testing for patients to receive the most appropriate management.

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There are many studies in the literature assessing various factors which influence the performance of visual field testing. But there are very limited data available and no Indian studies on the effect of anxiety on visual field testing.[8] So, we undertook this study to evaluate if automated perimetry testing induces anxiety and its effect on test performance. We also compared the anxiety levels induced by automated perimetry which is more patient-driven with that induced by optical coherence tomography (OCT) which requires minimal concentration.

## Methods

This prospective, comparative study was conducted on patients who attended the Glaucoma clinic at a tertiary eye care center in South India from June 2018 to June 2019. The study protocol was approved by the Institutional Ethics Committee (IEC/2017/0433) and abided by the tenets of the Declaration of Helsinki. Patients between 30 and 70 years of age with glaucoma (highest baseline IOP > 21 mmHg, glaucomatous optic neuropathy, and visual field defect conforming to Anderson's criteria for glaucoma), controlled on treatment, were recruited after informed consent. Patients with pre-existing anxiety disorders or depression on psychotropic medications were excluded.

As per standard practice, all patients were explained the procedure of visual field testing by an experienced optometrist. Further, the patients' experience with field testing was ascertained by noting the number of previous tests they had performed. Each eye's visual field was performed using a standard achromatic automated perimeter (Humphrey 750i, Carl Zeiss, Dublin, California, USA) with a 24-2 SITA Standard testing strategy. This was designated the HVF group. Only patients who performed reliable fields (False-positive <20%, False-negative <20%, and Fixation losses <15%) were included for the study. Another set of patients underwent retinal nerve fiber analysis using spectral-domain optical coherence tomography (SD-OCT) (Cirrus HD-OCT, Carl Zeiss Meditec, Inc, Dublin, California, USA), as a comparator group. This was designated the OCT group.

Participants' anxiety traits were assessed using the State-Trait Anxiety Inventory [STAI], which is a widely used validated measure of anxiety.[9] The STAI is comprised of two 20-item subscales; one measures persistent trait anxiety (how one generally feels, called Form Y2), and the other, state anxiety (how one feels "right now", called Form Y1). Participants rate each item on a four-point Likert scale ranging from 1 (not at all/almost never) to 4 (very much so/almost always). Both the forms (Y1 and Y2) are available as supplementary material (Annexures 1&2). Higher scores suggest higher anxiety levels. The tool has shown robust psychometric properties, including good internal consistency and acceptable test-retest reliability.

These questionnaires were administered in the local language (Tamil) or English for those who could read. The scale was read out to elicit the responses of those who could not read. Form Y2, which assessed the trait anxiety, was used to determine pretest anxiety proneness or nature.[10] In the HVF group, before starting the visual field testing, the participants completed Form Y1 to measure the current pretest level or 'State' anxiety [pretest anxiety]. Soon after the visual field testing, participants were retested on the Form Y1 questionnaire to assess the induced anxiety level during the visual field testing [Intratest anxiety]. Item scores on Form Y1 and Y2 were summed separately and used as continuous outcomes of state and trait anxiety, respectively.

Similarly, for the patients considered in the OCT group, after assessing the trait anxiety using Form Y2, the pretest and intratest anxiety were recorded before and after OCT testing using Form Y1.

The primary outcome measure was both groups' anxiety scores [trait, pretest, and intratest]. The secondary outcome parameters in the HVF group included the global indices [Mean deviation (MD) and pattern standard deviation (PSD)] and the reliability indices [False Positives (FP), False Negatives (FN), and Fixation Losses (FL)].

### Sample size estimation

Based on a previous study[8] comparing anxiety levels between standard automated perimetry (49%) and Heidelberg's retinal tomography (29%), which showed a 20% difference in anxiety level between the two techniques, with an allocation ratio of 2:1 between the two groups, confidence interval of 95%, and power of 80%, the sample size estimated was 228 [76 in the OCT group, 152 in the standard automated perimetry group]

### Statistical Analysis

The collected data were analyzed using descriptive and inferential statistics. Chi-square was used for measuring the differences between categorical variables. The independent samples t-test was used to evaluate the statistical significance of change between HVF and OCT groups of the measured variables. Spearman's correlational analysis was done to see the correlation between the HFA parameters (reliability and global indices) with the anxiety scores. Analysis of variance (ANOVA) was used to test the effect of the number of previous field tests on anxiety scores and reliability indices. A $P$ value of less than 0.05 was considered statistically significant. All statistical analyses were done using statistical software, IBM SPSS version 19.

## Results

A total of 228 patients were enrolled in the study with 152 participants in the HVF group and 76 in the OCT group. The mean age of the participants in the HVF group was 57.2 + 20.8 years (range 34-69 years) and in the OCT group was 56.8 + 20 years (range 33-69 years). Both the groups had similar proportions of men and women ($P$ = 0.78) [Table 1]. The scores for the trait, pretest, and intratest anxiety in both groups are shown in Fig. 1. Intratest anxiety scores were less than trait and pretest anxiety in both groups. However, this failed to show statistical significance. There was no significant difference in trait and pretest anxiety between the HVF group and the OCT group ($P$ = 0.971 and $P$ = 0.716). While there was no significant difference in intratest anxiety between the groups ($P$ = 0.332), the mean values were higher in the HVF group (42.13 ± 10.63) in comparison to the OCT group (40.71 ± 9.76) [Table 1].

The percentage mean values for the reliability indices (false-positive rate, false-negative rate, and fixation losses) and global indices (MD and PSD) in the HVF group are also given in Table 1.

An analysis of individual reliability indices and global indices, the false-positive rate showed significant negative correlation with trait anxiety (Spearman's r = -0.255, $P = 0.002$), pretest anxiety (Spearman's r = -0.247, $P = 0.002$), and intratest anxiety (Spearman's r = -0.232, $P = 0.004$). The other indices did not show any correlation with the anxiety scores [Table 2].

We did not find any correlation between the age and anxiety scores. A positive correlation between the pretest and intratest anxiety scores in the HVF group was found. No such correlation was seen for trait anxiety with pretest and intratest anxiety scores.

The effect of the number of previous HVF tests on anxiety scores and reliability indices has been depicted in Table 3. Most of the participants who had undergone the HVF tests had previous experience with field testing (2-5 times: n = 94, 61.84%). The anxiety scores were higher when the experience of previous HVF tests was <2 and least when the number of tests exceeded 5.

## Discussion

Visual field testing is a psychophysical test requiring a minimum level of understanding of the procedure and the ability to perform it correctly. Many patients find it a less-than-pleasant experience for glaucoma evaluation.[11] Anxiety can contribute to difficulty in its performance and has been correlated with poorer reliability indices in the past.[8] We evaluated the effect of visual field testing on patients' anxiety levels and tried to see if this correlated with poorer reliability indices, within the clinically acceptable criteria laid down for visual field tests.

In our study, mean trait, pretest, and intratest anxiety scores were higher in the HVF group when compared with the OCT group though they was not statistically significant. Chew *et al.*[8] did a prospective cohort study comparing anxiety scores between visual field testing (102 patients) and retinal nerve fiber imaging by Heidelberg Retinal Tomogram (HRT) (35 patients). The intratest anxiety was more in the HVF group than the HRT group in their study which is understandable given the patient's role in doing the test. In our study, there was no statistically significant difference in intratest anxiety between the HVF and OCT groups. The intratest anxiety scores were higher than the pretest anxiety scores in the HVF group which means that HVF increased intratest anxiety which could potentially affect test reliability. Hence, measures to reduce pretest anxiety such as a proper explanation of the test procedure and its importance to the patient can help reduce intratest anxiety, and thereby, improve the test performance. Chew *et al.*[8] also found a similar correlation between pretest and intratest anxiety.

Our study showed a negative correlation between pretest anxiety and intratest anxiety with false-positives in the HVF group which means that with an increase in anxiety, the false-positives decreased [Fig. 2]. Chew *et al.*[8] found a positive correlation between the pretest and false-positive scores. This difference in results may be because Chew *et al.* had included patients with false-positive rates up to 33%, while in our study, we excluded patients with false-positives of more than 20%. With a more stringent criteria, we should have probably evaluated a greater number of patients. A higher sample size is required when evaluating for smaller effects. Another explanation is that a certain amount of anxiety helps to improve test performance.

About pretest anxiety and false-negatives, there was no significant correlation which was like Chew *et al*. But they found a positive correlation between intratest anxiety and false-negatives. Like false-positives, the cutoff of 20% in our

**Table 1: Baseline parameters of the patients in the HVF and OCT groups**

| Parameters | HVF GROUP (*n*=152) | OCT GROUP (*n*=76) | *P* |
|---|---|---|---|
| Age (years) (Mean±SD) (Range) | 57.2±20.8 (34-69) | 56.8±20 (33-69) | 0.90 |
| Gender | | | |
| Male/Female | 83/69 | 40/36 | 0.78 |
| Anxiety Parameters | | | |
| (Mean±SD) (Range) | | | |
| Trait Anxiety | 45.76±9.34 (24-68) | 45.80±8.68 (24-68) | 0.10 |
| Pretest Anxiety | 43.66±11.19 (22-71) | 43.11±10.35 (22-71) | 0.72 |
| Intratest Anxiety | 42.13±10.63 (20-68) | 40.71±9.76 (20-60) | 0.33 |
| HVF measures | | | |
| Number of previous HVF tests | | | |
| Mean±SD (Range) | 2.76±1.27 (0-14) | 3.04±1.38 (0-14) | 0.13 |
| Reliability Indices (%) (Mean±SD) (Range) | | | |
| False positives | 9.03±1.81 (5-13) | - | |
| False negatives | 8.80±2.03 (4-15) | - | |
| Fixation losses | 9.32±2.41 (5-16) | - | |
| Global Indices (dB) (Mean±SD) (Range) | | | |
| Mean Deviation | -4.69±3.36 (-13.7 to -1.8) | - | |
| Pattern Standard Deviation | 3.92±2.03 (1.1 to 9.2) | - | |

HVF -Humphrey Visual Field, OCT-Optical Coherence Tomography, SD-Standard Deviation

**Table 2: Correlation between HFA parameters (reliability and global indices) and anxiety scores in the HVF group**

| Parameter | Trait Anxiety *r (P)* | Pretest Anxiety *r (P)* | Intra Test Anxiety *r (P)* |
|---|---|---|---|
| False-Positive | -0.255 (0.002) | -0.247 (0.002) | -0.232 (0.004) |
| False-Negative | 0.121 (0.139) | 0.107 (0.188) | 0.112 (0.171) |
| Fixation Losses | 0.025 (0.763) | 0.074 (0.363) | 0.080 (0.328) |
| Mean Deviation (dB) | 0.016 (0.845) | 0.050 0.539 | 0.027 0.742 |
| Pattern Standard Deviation (dB) | -0.004 (0.958) | -0.044 (0.594) | -0.024 (0.768) |

**Table 3: Effect of number of previous HVF tests on anxiety scores and reliability criteria**

| No of tests | Trait Anxiety Mean±SD (Range) | Pretest Anxiety Mean±SD (Range) | Intra Test Anxiety Mean±SD (Range) | False-positive (%) Mean±SD (Range) | False-negative (%) Mean±SD (Range) | Fixation losses (%) Mean±SD (Range) |
|---|---|---|---|---|---|---|
| < 2 (*n*=58) | 47.84±10.24 (29-68) | 47.31±10.65 (22-71) | 45.19±10.02 (20-68) | 9.36+2.03 (5-13) | 8.71+2.29 (4-15) | 10.26+2.73 (5-16) |
| 2-5 (*n*=70) | 45.31±8.80 (24-68) | 42.77±10.93 (22-71) | 41.07±11.14 (20-60) | 8.84+1.708 (5-13) | 8.86+1.8 (4-12) | 8.49+2.05 (5-15) |
| >5 (*n*=24) | 42.00±7.42 (30-54) | 37.46±10.34 (22-55) | 38.86±8.13 (21-56) | 8.75+1.42 (7-11) | 8.83+2.12 (5-12) | 9.50+1.69 (7-13) |
| *P* | 0.03 | 0.001 | 0.008 | 0.195 | 0.914 | <0.001 |

HVF -Humphrey Visual Field, SD-Standard Deviation

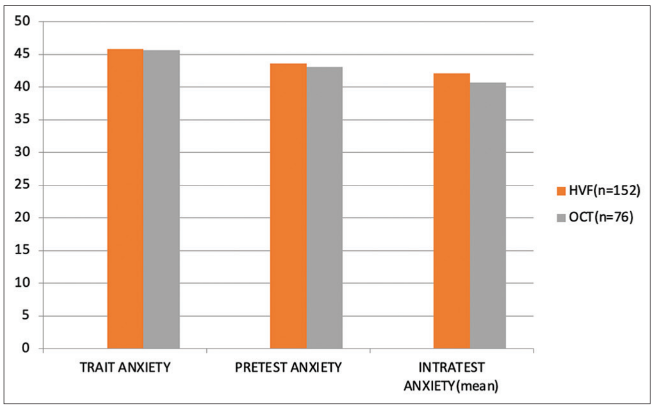


**Figure 1:** Bar diagram showing Mean anxiety scores in HVF and OCT group

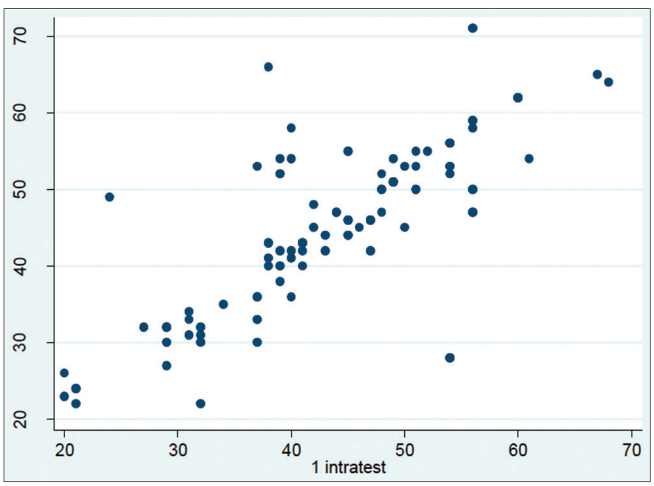


**Figure 2:** Pretest anxiety showing significant positive correlation with the intratest anxiety in the HVF group

study could have resulted in a discrepancy in results. No such correlation was observed for fixation losses.

We found no significant correlation between pretest and intratest anxiety with the global indices, MD, and PSD. In their study, Takahashi *et al.*[12] studied the quality of life in Japanese glaucoma patients and also evaluated the state of anxiety and anxiety about loss of vision by the STAI score. They found a positive correlation between state anxiety and mean deviation indicating that anxiety is more with worsening disease.

Pretest anxiety was significantly lower in patients who underwent more than five tests previously compared with patients who underwent it for the first time. Hence, patients who were familiar with visual field testing had less pretest and intratest anxiety scores. Patients undergoing the test for the first time were probably more anxious about their diagnosis and procedure. Generally, reliability improves in the second tested eye indicating that familiarity with the test practically is more important than other modes. Sherafat *et al.*[13] in their study reported significant improvement in the reliability following a training video about visual field testing. The video stressed the importance of maintaining fixation and not guessing the response. It familiarized the patient with the test procedure and reducing their stress. Rao *et al.*[14] too showed that patients viewing a training video followed by verbal instructions before the test led to significant improvement in test performance. This may be an effective strategy for reducing anxiety in new patients undergoing field testing to improve test reliability.

Ours is the first Indian study with adequate power to evaluate the role of anxiety in influencing the performance of visual field testing. One limitation of our study is that we have assessed anxiety using the STAI, which is more useful as a screening tool than a diagnostic measure for anxiety disorders. Since normative values have not been developed for the Indian population, it was unclear how many 'failed' the STAI screen. Future work may focus on developing and validating cutoff scores for ophthalmic disease populations which will assist in clinical evaluation and management. Another fallacy is that we determined stringent cutoffs for the reliability indices (False-positive <20%, False-negative <20%, and Fixation losses <15%), which may have inadvertently led to exclusion of the truly anxious patients in whom the reliability indices are affected by it. However, it also proves that the limits of reliability indices recommended by the manufacturer are robust. Also, we did not assess factors contributing to anxiety, like co-morbid illnesses, time of the day, distance traveled to the hospital, mode of transport used, presence or absence of a caregiver, or awareness of the disease. This may be the focus of future studies addressing factors related to poor results in psychophysical testing.

If anxiety is addressed, test performance improves and helps in better interpretation for the management of glaucoma. It also decreases the prospect of repeating the visual field tests, which is usually necessary if a field test does not meet the reliability criteria for interpretation. This would greatly save time and resources in the glaucoma clinic.

## Conclusion

Our study shows that anxiety with psychophysical testing (visual field test) is greater as compared to non-psychophysical test (OCT). This "state" anxiety reduces as patients gain familiarity with the test with experience. This adds credence to the recommendation of more frequent visual field testing in newly diagnosed glaucoma patients.

### Statement of ethics

Written informed consent for publication (including the images) has been obtained from the parent of the patient. All procedures carried out were as per the tenets of the Declaration of Helsinki. Institute Ethics Committee's approval is not required for a case report according to the Indian council of medical research guidelines.

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Nil.

### Conflicts of interest

There are no conflicts of interest.

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## Annexures 1&2

**QUESTIONARRE**

- **NAME**
- **AGE**
- **GENDER**
- **NUMBER OF PREVIOUS TESTS**

**Self- evaluation statements from STAI-T (FORM Y2) test for assessment of trait anxiety**

Participants are requested to tick the responses corresponding to what they feel usually.

| SI NO | STATEMENT | ALMOST NEVER | SOMETIMES | OFTEN | ALMOST ALWAYS |
|---|---|---|---|---|---|
| 1 | I feel pleasant | 4 | 3 | 2 | 1 |
| 2 | I feel nervous and restless | 1 | 2 | 3 | 4 |
| 3 | I feel satisfied with myself | 4 | 3 | 2 | 1 |
| 4 | I wish I could be as happy as others seem to be | 1 | 2 | 3 | 4 |
| 5 | I feel like a failure | 1 | 2 | 3 | 4 |
| 6 | I feel rested | 4 | 3 | 2 | 1 |
| 7 | I am “calm, cool and collected” | 4 | 3 | 2 | 1 |
| 8 | I feel difficulties are piling up so that I cannot overcome them | 1 | 2 | 3 | 4 |
| 9 | I worry too much over something that really does not matter | 1 | 2 | 3 | 4 |
| 10 | I am happy | 4 | 3 | 2 | 1 |
| 11 | I have disturbing thoughts | 1 | 2 | 3 | 4 |
| 12 | I lack self-confidence | 1 | 2 | 3 | 4 |
| 13 | I feel secure | 4 | 3 | 2 | 1 |
| 14 | I make decisions easily | 4 | 3 | 2 | 1 |
| 15 | I feel inadequate | 1 | 2 | 3 | 4 |
| 16 | I am content | 4 | 3 | 2 | 1 |
| 17 | Some unimportant thought runs through my mind and bothers me | 1 | 2 | 3 | 4 |
| 18 | I take disappointments so keenly that I cannot put them out of my mind | 1 | 2 | 3 | 4 |
| 19 | I am a steady person | 4 | 3 | 2 | 1 |
| 20 | I get in a state of tension or turmoil as I think over my recent concerns and interests | 1 | 2 | 3 | 4 |

**Self evaluation statements from STAI- S(Form Y1)**

Participants need to tick the appropriate response as how they feel 'right now' or at this moment before taking the test.

| SI NO | STATEMENT | NOT AT ALL | SOME-WHAT | MODERATELY | VERY MUCH SO |
|---|---|---|---|---|---|
| 1 | I feel calm | 4 | 3 | 2 | 1 |
| 2 | I feel secure | 4 | 3 | 2 | 1 |
| 3 | I am tense | 1 | 2 | 3 | 4 |
| 4 | I am strained | 1 | 2 | 3 | 4 |
| 5 | I feel at ease | 4 | 3 | 2 | 1 |
| 6 | I feel upset | 1 | 2 | 3 | 4 |
| 7 | I am presently worrying over possible misfortunes | 4 | 3 | 2 | 1 |
| 8 | I feel satisfied | 1 | 2 | 3 | 4 |
| 9 | I feel frightened | 4 | 3 | 2 | 1 |
| 10 | I feel comfortable | 4 | 3 | 2 | 1 |
| 11 | I feel self-confident | 1 | 2 | 3 | 4 |
| 12 | I feel nervous | 1 | 2 | 3 | 4 |
| 13 | I am jittery | 1 | 2 | 3 | 4 |
| 14 | I feel indecisive | 4 | 3 | 2 | 1 |
| 15 | I am relaxed | 4 | 3 | 2 | 1 |
| 16 | I feel content | 1 | 2 | 3 | 4 |
| 17 | I am worried | 1 | 2 | 3 | 4 |
| 18 | I feel confused | 4 | 3 | 2 | 1 |
| 19 | I feel steady | 4 | 3 | 2 | 1 |
| 20 | I feel pleasant | 1 | 2 | 3 | 4 |

**Post Test Questionnaire** (Five Point Likert scales)

Participants are asked to mark their responses to specific questions on various parameters during the test with the following scales.

| PARAMETER | NOT AT ALL | A LITTLE | MODERATELY | VERY | EXTREMELY |
|---|---|---|---|---|---|
| Anxious | 1 | 2 | 3 | 4 | 5 |
| Difficult | 1 | 2 | 3 | 4 | 5 |
| Tiring | 1 | 2 | 3 | 4 | 5 |
| Long | 1 | 2 | 3 | 4 | 5 |
| Uncomfortable | 1 | 2 | 3 | 4 | 5 |
| Unpleasant | 1 | 2 | 3 | 4 | 5 |