The Effects of Mozart’s Music on the Performance of Glaucoma Patients on Automated Perimetry

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Purpose. The purpose of this study was to examine the impact of the Mozart effect on the reliability of the Humphrey visual field (HVF; Carl Zeiss Meditec, Dublin, CA) test in subjects with glaucoma. A previous study showed improved reliability in normal subjects undergoing HVF testing.

Methods. One hundred sixty subjects with glaucoma were randomized to three groups: control, headphones, or music for 10 minutes before HVF testing. The headphone group was provided noise-cancellation headphones but no music. The music group listened to Mozart’s Sonata for Two Pianos in D Major. After treatment, subjects took an HVF test in both eyes. The reliability of the test was then compared between the groups and also to prior HVF results with regard to fixation losses, false positives, and false negatives.

Results. The rate of fixation losses did not differ significantly between the three groups (P = 0.30 right eye; P = 0.24 left eye). There were also no significant differences in the rate of false positives (P = 0.82 right eye; P = 0.18 left eye) or false negatives (P = 0.91 right eye; P = 0.97 left eye). The reliability of the subject’s HVF result was also compared with past field results. No improvements were seen in fixation losses (P = 0.94 right eye, P = 0.17 left eye), false positives (P = 0.85 right eye, P = 0.38 left eye), and false negatives (P = 0.13 right eye, P = 0.50 left eye).

Conclusions. The rate of fixation losses, false positives, and false negatives did not improve in subjects with glaucoma after they listened to Mozart’s music. The Mozart effect did not enhance the reliability of the visual field test to a statistically significant degree (ClinicalTrials.gov number, NCT01027039). (Invest Ophtalmol Vis Sci. 2011;52:7347–7349) DOI:10.1167/iovs.11-7430

The “Mozart effect” is a well-documented phenomenon that has been studied across multiple disciplines. Its proponents argue that listening to Mozart’s Sonata for Two Pianos in D Major (K448) can transiently increase temporal–spatial reasoning.1 Mice exposed to Mozart’s music during development navigated mazes faster and with fewer errors than mice raised on a background of white noise.2 In humans, subjects’ performance on temporal–spatial tests such as paper-folding tasks improved after listening to Mozart’s music.3 These findings have led to the application of Mozart’s music as an alternative treatment for conditions such as depression and anxiety.4,5 One application of the Mozart effect in clinical ophthalmology has been its use to attempt to improve visual field test reliability. Medical students who listened to 10 minutes of Mozart’s music made significantly fewer fixation losses (FLs), false positive (FP) errors, and false negative (FN) errors than their nonexposed counterparts.6

Glaucoma is a debilitating disease that affects more than 60 million people worldwide and is the second leading cause of blindness.7 Visual field testing is used to assist in the diagnosis and monitoring of glaucoma. However, variable patient responses decrease the utility of the test; causes of this variability include failure to follow instructions and loss of concentration. The purpose of this study was to examine the impact of the Mozart effect on the reliability of visual field test results (Humphrey Visual Field perimeter [HVF]; Carl Zeiss Meditec, Dublin, CA) in subjects with glaucoma.

Methods

This prospective, randomized control study was approved by the Wills Eye Institutional Review Board (IRB 07-829E). All procedures were in accordance with the Declaration of Helsinki of 1975, as revised in 1983. A total of 105 subjects from the Wills Eye Institute glaucoma service and 59 subjects from the Hospital Universitario de La Ribera, Alzira, Spain, were recruited during office visits between 2008 and 2009. Subjects reviewed and signed an informed consent before their enrollment in the study.

Patients between the ages of 40 and 80 were considered for the study. To qualify, patients must have had glaucoma diagnosed by a physician, have taken at least two prior SITA-standard visual field tests, and have had best corrected visual acuity of at least 20/50 in both eyes. Types of glaucoma acceptable for this study were open-angle, closed-angle, normal-pressure, exfoliation, and neovascular glaucoma. Visual acuity was measured the day of each field test by staff technicians.

Patients with inflammatory glaucoma were excluded. In addition, patients with mean deviations exceeding −15 dB, either FPs or FNs exceeding 40%, or FLS exceeding 50% were not included. These reliability parameter values were chosen to ensure that the subjects had a reasonable ability to take the test, but were not such experts that interventions would not be able to show improvement. Other exclusion criteria included presence of ocular diseases affecting central vision such as macular scarring, age-related macular degeneration, diabetic retinopathy, and nuclear sclerotic greater than 2+ (graded 0–4). Finally, patients with dementia, stroke, severe arthritis, hearing loss, or any other systemic conditions that prevented them from taking visual field tests were excluded.

Once recruited, subjects were randomized into one of three groups, which determined the intervention before visual field exami-
nation. For 10 minutes immediately before visual field testing, the subjects were seated, alone, in a quiet room dedicated to the study. They had one of three random exposures: (1) Those in the control group were not provided music or headphones; (2) those in the noise-reduction group were provided headphones with noise cancelation but no music; (3) those in the music group were provided the same headphones over which they heard Mozart’s Sonata for Two Pianos in D Major. The purpose of the noise-reduction group was to separate possible changes in visual field reliability caused by Mozart’s music from those caused by headphones alone. After treatment, patients immediately received standardized instructions on how to take the visual field test. First the right and then the left eye was tested with the 24-2 SITA Standard (Carl Zeiss Meditec) with appropriate spectacle correction adjusted for testing distance. No more than 2 minutes elapsed from the time subjects concluded their treatment to the time they started the visual field test. After the test, patients completed a survey asking whether they would prefer to listen to Mozart before future visual field tests.

After the visual field test, data were collected for each subject’s FLs, FPs, FNs, mean standard deviation, pattern standard deviation, time of day, test duration, and questionnaire answers. Intrasubject differences were assessed using these data and results from each subject’s two prior visual fields. Intersubject differences were assessed using only the data collected for the study. The left and right eyes were analyzed separately. The Kruskal-Wallis test was used to compare the groups. 

RESULTS

One hundred five subjects completed the study: 36 in the control group (average age 65, 27 women), 29 in the noise-reduction group (average age 65, 14 women), and 40 in the music group (average age 66, 30 women).

Table 1 shows reliability indices by group for the automated perimetry. Table 2 shows the intergroup differences, comparing the control group with the Mozart group. The median reliability generally remain stable. There was also no significant change in reliability between the three groups when compared over the course of a few years, their test-taking abilities and reliability generally remain stable. There was also no significant change in reliability between the three groups when compared to past visual field results.

There are numerous possible explanations for why Mozart’s music failed to improve reliability in this study. The original study was conducted on a population of naive test-takers, while subjects in this study were required to have taken at least two prior visual fields. Therefore, the Mozart effect observed in the previous study might actually target a subject’s ability to

### TABLE 2. Intergroup Differences, Control Group versus Mozart Groups

<table>
<thead>
<tr>
<th></th>
<th>FP</th>
<th>FN</th>
<th>FL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Right</td>
<td>0.82</td>
<td>0.91</td>
<td>0.30</td>
</tr>
<tr>
<td>Left</td>
<td>0.18</td>
<td>0.97</td>
<td>0.24</td>
</tr>
</tbody>
</table>

*P values: Kruskal-Wallis tests for differences between groups.*

In this study, having subjects with glaucoma listen to Mozart’s Sonata K448 did not appear to have any beneficial effect on how reliably they performed the visual field examination. The main parameters examined in this study were FP, FN, and FL. FPs are generated when a subject records a stimulus when none was presented. FNs are generated when a subject fails to record a stimulus despite having successfully responded to previous stimuli of equal or greater magnitude in the same location. FLs are generated when a subject records a stimulus in a portion of the visual field established as their physiologic blind spot. Together, these reliability indices reflect the subjects’ ability to stay alert and maintain concentration throughout the duration of the test.

In a previous study of 60 nonglaucomatous, naive subjects with a mean age of 22.6 years, listening to Mozart’s music before performing a visual field examination was associated with a significant reduction in the number of FPs, FNs, and FLs generated on the visual field test.6 The present study considered a different population; subjects were older, had glaucoma, and were experienced in taking visual field tests. This study also assessed for the possibility that noise-cancellation headphones alone could affect visual field testing performance. As shown, the music group exhibited no signs of improved reliability in comparison to the control. The noise-reduction group also exhibited no significant improvements. This study had a more than 80% power to detect a difference if the true rate of FLs or FNs was 5% in the control group and 2% in the noise reduction and/or Mozart groups, assuming a Kruskal-Wallis test with a two-sided type I error rate of 5%.

To examine more accurately the effects of listening to Mozart’s music, each subject’s visual field result was compared to those of at least two visual fields taken in the past. It is well established that although a patient’s visual field might change over the course of a few years, their test-taking abilities and reliability generally remain stable. There was also no significant change in reliability between the three groups when compared to past visual field results.

DISCUSSION

The posttest survey showed that 65% of subjects in all groups wanted to listen to Mozart’s music before future visual field tests.
learn how to take the visual field test rather than his or her reliability on the test. It is also possible that the effects of Mozart’s music are decreased in older patients or in patients with glaucoma. In addition, the visual field test reliability indices may not be sensitive enough to pick up subtle improvements in patient performance. Since a reliable visual field generally requires the FP, FN, and FL rates to be under 30%, it might be possible that the Mozart effect becomes evident only in subjects with worse baseline reliability. Most of the subjects in our study demonstrated high baseline reliability, scoring below 15% on all indices. In the future, it may be useful to examine test takers with worse reliability indices.

The Mozart effect has been shown to last only 10 minutes.1 Our subjects started the visual field test 2 minutes after the conclusion of the treatment to ensure that they would receive any benefits from the Mozart effect. Since the right eye was tested first, it is possible that any presumed Mozart effect had dissipated by the time the left eye was tested. However, the results show that there was no significant improvement in reliability compared with previous visual field tests in either eye individually. In addition, it would be difficult to assess for any differences in reliability between the right and left eyes since other factors including fatigue and decreased concentration could affect the results.

Mozart music’s ability to improve spatial-temporal reasoning has been attributed to improved neuronal firing patterns within the cortex, as described by the Trion model. Rauscher et al.8 performed a series of experiments demonstrating the positive effects of Mozart in paper-folding and maze-navigation tests. In addition, Fiorelli et al.6 proposed that Mozart stimulates pathways for visual image processing. The improvements bestowed by Mozart’s music are either missing or significantly decreased in experienced, elderly patients with glaucoma. It is possible that either age or glaucoma have negatively affected these pathways due to neurodegeneration over time. These pathways may also be less susceptible to the effects of Mozart’s music once the subject has already learned and practiced the visual field test and does not benefit as much as a naïve test-taker would.

Although this study was not specifically designed to address subjects’ preferences regarding Mozart’s music, the survey did show that most of our subjects wanted to listen to Mozart’s music before future visual field tests.

This study’s results do not exclude the existence of a Mozart effect, nor do they exclude the Mozart effect’s potential utility in other patient populations. We do call into question the practicality of using Mozart to improve field testing in a clinical setting. The Mozart effect, as described by Rauscher et al.,1 is short-lived, lasting approximately 10 minutes, implying that it would be unlikely to be clinically applicable in cases where patients take greater than 10 minutes to complete their visual field tests. In future studies, researchers may wish to examine the effects of Mozart played during the visual field test, an approach that may be more feasible clinically. The study can also be augmented by including an additional control group exposed to background noise to simulate the clinical setting more accurately.

In conclusion, in this study, Mozart’s Sonata for Two Pianos in D Major did not significantly improve the reliability of the visual field test results in elderly patients with glaucoma who were experienced in performing the visual field test.

### References


### Table 3. Change from Baseline in FP, FN, and FL by Eye and Group

<table>
<thead>
<tr>
<th>Eye/Group</th>
<th>n</th>
<th>FP</th>
<th>FN</th>
<th>FL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Right</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Control</td>
<td>36</td>
<td>0.00 (−12.0, 24.00)</td>
<td>0.00 (−23.0, 17.00)</td>
<td>5.41 (−87.5, 100.0)</td>
</tr>
<tr>
<td>Noise-reduction</td>
<td>29</td>
<td>0.00 (−16.0, 8.00)</td>
<td>0.00 (−17.0, 19.00)</td>
<td>0.55 (−60.0, 72.38)</td>
</tr>
<tr>
<td>Mozart</td>
<td>40</td>
<td>0.00 (−34.0, 27.00)</td>
<td>−1.50 (−14.0, 6.00)</td>
<td>7.06 (−66.7, 51.90)</td>
</tr>
<tr>
<td>Left</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Control</td>
<td>36</td>
<td>1.00 (−9.00, 22.00)</td>
<td>0.00 (−24.0, 26.00)</td>
<td>5.77 (−66.7, 100.0)</td>
</tr>
<tr>
<td>Noise-reduction</td>
<td>29</td>
<td>0.00 (−8.00, 22.00)</td>
<td>0.00 (−11.0, 19.00)</td>
<td>0.00 (−76.9, 60.00)</td>
</tr>
<tr>
<td>Mozart</td>
<td>40</td>
<td>0.50 (−12.0, 17.00)</td>
<td>0.00 (−28.0, 10.00)</td>
<td>6.22 (−56.3, 100.0)</td>
</tr>
</tbody>
</table>

n = 105.

### Table 4. Intrasubject Differences, Comparing the Control Group to the Mozart Group

<table>
<thead>
<tr>
<th>Eye</th>
<th>FP</th>
<th>FN</th>
<th>FL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Right</td>
<td>0.85</td>
<td>0.13</td>
<td>0.94</td>
</tr>
<tr>
<td>Left</td>
<td>0.38</td>
<td>0.50</td>
<td>0.17</td>
</tr>
</tbody>
</table>

*P*-value: Kruskal-Wallis tests for differences between groups.