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Abstract

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Degree Type

Thesis

Degree Name

Master of Science in Vision Science

Committee Chair

Lee Ann Remington

Subject Categories

Optometry

EFFECTS OF ALCOHOL ON CENTRAL AND PERIPHERAL VISUAL FIELDS

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and
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A Thesis submitted to the faculty of the
College of Optometry
Pacific University
Forest Grove, Oregon
for the degree of
Doctor of Optometry
May, 1992

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The author began undergraduate studies in Nevada, where she attended both the Western Nevada Community College and the University of Nevada, Reno. She received an AA degree in General Studies from WNCC, then transferred to Pacific University where she completed her undergraduate studies while simultaneously working on her degree for Doctor of Optometry. She received a BS in Visual Science in 1990 from Pacific University. She will complete requirements for the Doctor of Optometry degree in May of 1992.

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Author's undergraduate studies were completed at Western New Mexico University. There she received a B.S. in General Science. She is currently working on her Doctor of Optometry degree at Pacific University and will graduate in May of 1992.

Awards and Activities include: Membership in Cardinal Key Honor Society, Junior Class Senator of WNMU, Nominations to The National Dean's List and Who's Who in American Colleges and Universities while an undergraduate student. Graduate Studies Awards and Activities include: Beta Sigma Kappa Honor Fraternity, Who's Who in American Colleges and Universities, with membership in American Optometric Student Association. Author plans to return to New Mexico, her home state, to become an associate and eventual partner in a full-scope optometric practice. Her interests lie in primary vision care with emphasis on binocular vision and children.

ABSTRACT

Tunnel vision is a phenomenon that has often been attributed to alcohol intoxication. Past studies report conflicting results regarding the extent of visual field loss due to alcohol. This study attempted to resolve the conflicts in the literature and to determine if in fact peripheral visual field constrictions do occur.

A population of 17 subjects, each acting as his own control participated in the clinical trials. Visual fields using the Humphrey Field Analyzer were run on each subject before alcohol ingestion and shortly after reaching a BAC (blood alcohol concentration) of .08-.13, as measured by breath analysis.

Results indicated a statistically significant increase ($p=.013$) in peripheral points missed. However, losses were random, not constrictive, and if mean losses were examined, the results were not *clinically* significant. While visual field changes did occur, the phenomenon of tunnel vision was not elicited.

Acknowledgements: We would like to thank Drs. Robert Yolton and Bradley Coffey for their advice and guidance with the statistics of our research, Dr. Jurgan Meyer-Arendt for translating our German article, and Officer Gary Wright for his assistance with our study.

Introduction

Many anecdotal instances of tunnel vision have been associated with the consumption of alcohol. The phenomenon has been reported by intoxicated automobile drivers,[1] and has been the subject of a number of previous studies. These studies reported conflicting results regarding extent of visual field loss due to the consumption of alcohol. This study attempts to resolve some of the conflicts in the literature.

Some of the conflicts may have been due to the use of different perimeters and protocols. Differing levels of intoxication both within the studies and between them may also be a cause for disagreement. Other confounding factors may have been inattention (due to the length of the test) and inability to comply due to excessive intoxication.

The use of different perimeters and protocols may have been the most influential confounding factors in comparing the results of the previous studies. Colson used a "standard perimeter" (circa 1940) to test the "four cardinal directions", and found no difference in fields after alcohol consumption.[2] Hill and Toffolon used the Goldman perimeter with setting I4e and ran Pearsons correlation on the vertical and horizontal meridians only. They found losses which were significant, but which were not extensive enough to be considered "tunnel vision".[3] An Octopus temporal crescent (program 51) was run on the subjects in the Riedel, Gilg, and Liebhardt study. They found statistically significant concentric restrictions using the t-test for analysis. They also reported small and highly random relative scotomas which they compared to those found in diabetic retinopathy within the temporal crescents.[4]

Alternately, Skalka, Helms and Holman found no statistically significant change in the visual field after alcohol ingestion using the Goldman perimeter.[5] Zulauf, Flammer and Signer achieved the same result using the Octopus perimeter with program JO, which tested a total of 47 locations in a grid pattern extending 36 degrees vertically and 48 degrees horizontally.[6] In contrast with the other groups who had focused on searching for peripheral changes, the Zulauf study examined the effects of intoxication on in-office perimetry.

Alcohol protocol was another confounding factor in comparing the different studies, as the amount of alcohol and blood alcohol concentration (BAC), as well as the time allowed for alcohol ingestion varied considerably. Among the guidelines used for the amount of alcohol consumed were: drink until subjects could no longer perform test, drink until a subjective level of intoxication was reached, or drink until a given BAC, either measured or approximated, was reached. Research done by H. Moskowits and M. Burns indicated that the time allowed for alcohol ingestion affects the subjects' performance in testing. Their study showed significant behavioral changes in subjects when a relatively short time period of 30 minutes was taken for drinking. These changes became less evident as drinking times were lengthened.[7]

Alcohol is known to cause behavioral changes which may not be conducive to active and conscientious participation in an experimental study. Zulauf and Riedel both reported high numbers of fixation losses, false positive errors, and false negative errors.[6,4] (These numbers are clinically assessed as indications of the subject's reliability.) While they offered no explanations, a work by R. Gustafson which reports on the effect of alcohol on the visual attention span may substantiate alcohol as the causative agent for the unreliable test results.[8] The length of time necessary to complete the tests may also be one of the factors which caused increases in the subjects' reliability factors.

Methods

The study began with a population of 20 subjects, 7 women and 13 men. Two subjects dropped out of the study due to illness; one prior to testing, the other during alcohol ingestion. A third subject was dropped by the researchers for lack of co-operation during sober field testing. Thus, the study was completed with a population of 17.

All subjects were optometry students between the ages of 23 and 31. Each was questioned in advance concerning health and drinking habits. All were healthy, free of medication, and classified themselves as mild to moderate social drinkers. Subjects had normal visual fields and visual acuities correctable to 20/20 Snellen or better with each eye. Only subjects who had previously undergone visual field testing using the Humphrey Field Analyzer were accepted to the study.

A custom full field visual screening test was created consisting of a uniform grid of 91 points with 10 degree separation. The grid ranged horizontally from 50 degrees right field to 40 degrees left field, and extended 50 degrees superiorly to 50 degrees inferiorly. The Humphrey threshold related strategy with the standard white, size III stimulus was used. This strategy tests each point at a level 6dB brighter than expected. It records points missed twice at that level as defects. Approximately six minutes were necessary to test each eye. Immediately following the completion of the field exam of each eye all defects were retested utilizing the same strategy. Retesting, on average, took no more than three minutes. This design decreased the time subjects spent in the perimeter as compared to existing full field programs, yet still provided enough points and sensitivity to pick up any significant scotomas or field constrictions. As noted in the previously, we felt that the length of time spent taking the test directly affected the attention and cooperation of the subjects.

Visual fields were run with subjects both sober and intoxicated, with each subject acting as his own control. One half of the subjects performed the field test first while sober, the other was first tested while intoxicated. Subjects had been instructed not to eat for 6 hours prior to testing, and to consume no alcohol for the preceding 24 hours. Intoxication was achieved by the administration of pure grain alcohol mixed with orange juice and ice. The BAC chosen for this study was 0.1 (the national legal limit for driving). Amounts necessary to reach this level were estimated using subjects' body weights, and were ingested over a period of approximately one hour. A member of the local police department measured the BACs of our subjects using the Intoxilizer, the breath analyzer they currently use to evaluate suspected drunken drivers. Subjects' BACs were frequently monitored after the first 1/2 hour. The range of BACs was .08-.13.

Both eyes were tested and the findings averaged. Comparison between the results with and without alcohol was done using the two-tailed student's t-test and a significance level of $p=.05$.

Results

A summary of the data gathered for the indivual subjects is shown in Table 1. The number of points missed in the central 30 degrees after the consumption of alcohol was statistically insignificant ($p=.54$.) The periphery (outside of 30 degrees) showed a statistically significant number of points missed ($p=.013$) with the ingestion of alcohol, however, losses were random and not constrictive Utilizing clinical criteria which identifies an abnormal field as two or more adjacent points or three scattered points missed, the *clinical* significance of these losses is questionable[9,10]. The average number of points missed when sober was 1.206 while the average missed when intoxicated was 2.824

Subject	Sex	BAC	Sober Points Missed Central	Intoxicated Points Missed Central	Sober Points Missed Peripheral	Intoxicated Points Missed Peripheral	Difference Between Points Missed Intoxicated and Sober	Sober Points Missed Upon Retest	Intoxicated Points Missed Upon Retest
1	F	0.08	0.00	0.00	0.50	7.00	6.50	0.00	0.50
2	M	0.12	0.00	0.00	1.00	1.00	0.00	0.00	0.00
3	M	0.10	0.00	0.00	1.00	3.50	2.50	0.00	1.00
4	M	0.12	0.00	0.00	0.00	2.50	2.50	0.00	0.00
5	F	0.10	0.00	0.00	1.50	2.00	0.50	1.00	0.00
6	M	0.13	0.00	0.00	0.00	0.00	0.00	0.00	0.00
7	F	0.11	0.00	0.00	0.00	3.50	3.50	0.00	0.50
8	M	0.12	0.00	0.00	3.00	0.50	-2.50	1.00	0.00
9	M	0.13	0.00	0.00	0.00	3.00	3.00	0.00	2.00
10	F	0.10	0.00	0.00	0.00	6.00	6.00	0.00	
11	M	0.09	0.00	3.00	3.50	3.50	0.00	0.00	0.00
12	M	0.12	0.00	0.00	1.00	2.50	1.50	1.00	0.00
13	M	0.10	1.00	0.00	0.00	2.50	2.50	0.00	1.50
14	F	0.09	0.00	0.00	2.50	4.00	1.50	1.00	0.00
15	M	0.10	0.00	0.00	1.50	2.00	0.50	0.00	0.00
16	F	0.13	0.00	0.00	3.50	1.50	-2.00	0.00	0.00
17	M	0.11	0.00	0.00	1.50	3.00	1.50	1.00	1.00

Table 1: Individual Subject Data

All points missed during both "sober" and "intoxicated" fields were retested immediately after the field test was done. The number of misses upon retest was found to be statistically insignificant for both central and peripheral fields ($p=.676$). See Table 1.

	Sum	Average	Minimum	Maximum
Points Missed Sober-Central	1.00	0.06	0.00	1.00
Points Missed Intoxicated-Central	3.00	0.18	0.00	3.00
Points Missed Sober-Peripheral	20.50	1.21	0.00	3.50
Points Missed Intoxicated-Peripheral	48.00	2.82	0.00	7.00
Fixation Losses Sober	0.70	0.04	0.00	0.11
Fixation Losses Intoxicated	1.38	0.08	0.00	0.22
False Positive Errors Sober	0.67	0.04	0.00	0.15
False Positive Errors Intoxicated	0.67	0.04	0.00	0.28
False Negative Errors Sober	0.10	0.01	0.00	0.10
False Negative Errors Intoxicated	0.77	0.05	0.00	0.40
Points Missed on Retest Sober	5.00	0.29	0.00	1.00
Points Missed on Retest Intoxicated	6.50	0.41	0.00	2.00

Table 2: Cumulative Data

Statistics comparing "sober" and "intoxicated" fields for the number of fixation losses, false positive errors, and false negative errors all showed no significance. See Table 2.

Subject	Sex	BAC	Sober Fixation Losses	Intoxicated Fixation Losses	Difference Between Sober and Intoxicated Fixation Losses	Sober False Positive Errors	Intoxicated False Positive Errors	Sober False Negative Errors	Intoxicated False Negative Errors
1	F	0.08	0.07	0.14	0.07	0.04	0.00	0.00	0.10
2	M	0.12	0.11	0.10	-0.01	0.15	0.07	0.00	0.00
3	M	0.10	0.00	0.07	0.07	0.00	0.00	0.00	0.10
4	M	0.12	0.00	0.04	0.04	0.00	0.00	0.00	0.00
5	F	0.10	0.00	0.04	0.04	0.00	0.00	0.00	0.00
6	M	0.13	0.07	0.04	-0.03	0.00	0.07	0.00	0.00
7	F	0.11	0.00	0.17	0.17	0.04	0.07	0.00	0.17
8	M	0.12	0.08	0.04	-0.04	0.04	0.00	0.00	0.00
9	M	0.13	0.00	0.21	0.21	0.07	0.00	0.00	0.00
10	F	0.10	0.04	0.00	-0.04	0.04	0.00	0.00	0.00
11	M	0.09	0.07	0.00	-0.07	0.14	0.00	0.00	0.00
12	M	0.12	0.00	0.20	0.20	0.04	0.07	0.00	0.00
13	M	0.10	0.07	0.04	-0.03	0.00	0.00	0.00	0.40
14	F	0.09	0.00	0.00	0.00	0.04	0.04	0.00	0.00
15	M	0.10	0.11	0.22	0.11	0.07	0.28	0.00	0.00
16	F	0.13	0.04	0.04	0.00	0.00	0.00	0.00	0.00
17	M	0.11	0.04	0.03	-0.01	0.00	0.07	0.10	0.00

Table 3: Reliability Factors

Discussion

This study was designed to increase the number of variables controlled. Factors considered important to control were: objectivity in testing, subject inattention, test sensitivity, alcohol protocol and subject motivation. The following discussion addresses these issues.

To eliminate problems associated with manual perimetry and to provide a standardized testing protocol, an automated perimeter was used. This very nearly eliminates examiner technique and bias.

The Humphrey perimeter was chosen because it is widely used in the United States.

The brief, screening visual field test used in this study was created as an attempt to increase patient reliability by decreasing the amount of time in testing. However, some test sensitivity may have been compromised by utilizing the custom program as it would not allow for the test grid to be utilized through the full extent of the visual field. The ideal test would have extended to the physiological visual field limits of 90 degrees temporally, 60 degrees nasally, 50 degrees superiorly and 75 degrees inferiorly. If the temporal crescent had been included (in order to extend the range of the field tested), it would have doubled the test time, thereby negating the most important benefit of the custom design. The temporal crescent by itself would have provided a great deal of information about that area, however, in light of the "relative scotomata" found by Riedel, et al.,[4] it was felt that for a more complete test, the full visual field should be sampled. It was felt that the program was extensive enough to identify a significant constriction. While watching the visual field testing progress, it was noted that in some of the subjects up to 15 points were missed, sometimes along the inferior, outer borders, and others in a random fashion. Most of these missed points were seen when presented a second time. Of those, missed twice few were actually indicative of a field defect since they were seen on a retest.

There were no significant changes in the number of fixation losses or false negative errors indicating that the subjects were able to maintain adequate attention while in the intoxicated state. The target BAC chosen was 0.1%. This was used for two reasons: it is the national legal limit for driving and it is not so high that the subjects would be unable to cooperate. For statistical purposes, a small range of BACs was maintained. In an attempt to get more reliable visual field results the subjects were allowed an hour to consume the alcohol and to achieve the target BAC. This was to allow for enough time for the alcohol level to stabilize and for the subjects to become adapted to their intoxicated state.[7]

Other studies noted a problem with subject motivation; it was not a factor in this study. The subjects were all optometry students and were exceptionally motivated to do well. Some showed signs of greater motivation during "intoxicated" fields than "sober" ones. As a result, some actually missed less points in the intoxicated state. However, these subjects also appeared to be the more experienced drinkers in the group, showing less behavioral and motor signs overall. An attempt to compare the more experienced drinkers with the light drinkers statistically was felt to be too subjective and had too many confounding factors to give reliable results. It was interesting to note that the signs of intoxication between subjects was quite variable, ranging from extremely obvious (staggering and giggling) to almost indistinguishable, in spite of the fact that the BACs were similar. A number of subjects noticed movement of the fixation light indicative of vertical nystagmus, and a few were nauseous during the test. In spite of these difficulties, cooperation was not a problem.

A confounding factor not addressed in this study was that of the effect of cognitive load on peripheral vision. Research has been done by authors outside of the visual sciences which has shown that peripheral vision decreases as central load is increased.[11,12,13] These works cannot be directly compared to works such as those previously mentioned because their protocols are radically different from the visual science protocols. For example: Moskowitz and Sharma did binocular peripheral field testing using dim 2mm red lights with dark-adapted subjects.[11] It has been argued that field testing demands little central processing, and is therefore inappropriate to measure the loss of peripheral field during driving. However, studies involving foveal loading using letters and centrally tested points[12,13] are also inappropriate when trying to establish "real life" relevance.

While the dangers of drinking and driving are self-evident, this study did not substantiate the phenomena of tunnel vision since testing resulted in random point losses only. It is obvious that visual field testing would be inappropriate to determine whether or not a driver was legally drunk. The kind of confrontation field testing that would be used in such a situation would be far too gross to pick up such subtle field changes.

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