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The Effects of Decreased Uncertainty and Telescopic Versus Full Field Training on The Useful Field of View

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THE EFFECTS OF DECREASED UNCERTAINTY AND TELESCOPIC VERSUS FULL FIELD TRAINING ON THE USEFUL FIELD OF VIEW

A Thesis

Presented to

the Faculty of the Department of Psychology

Western Kentucky University

Bowling Green, Kentucky

In Partial Fulfillment

of the Requirements for the Degree

Master of Arts

by

Lauren M. Jackson

February 1990

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THE EFFECTS OF DECREASED UNCERTAINTY AND TELESCOPING VERSUS FULL FIELD TRAINING ON THE USEFUL FIELD OF VIEW

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Lauren M. Jackson February, 1990 86 Pages
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The "Useful Field of View" (UFOV) is the entire area in which information can be gathered without moving the eyes or head (Ball, Beard, Roenker, Miller & Griggs, 1988). Previous research has demonstrated that the UFOV shrinks with age (Scialfa, Kline & Lyman, 1987; Plude & Doussard-Roosevelt, 1987; Ball et al., 1988). With a decrement in the UFOV, everyday activities, such as driving and walking can be limited. If the area in which information is received is smaller, then objects seem to appear suddenly and there is little time to react to them. One example of an everyday activity that would be affected by this decrement is driving. Driving involves simultaneously attending to a number of different elements at the same time, for example, speed, oncoming traffic, traffic signals and signs and pedestrians. A decrement of the UFOV would adversely affect driving performance.

Only two studies have looked at training to increase the deficit in the UFOV (Sekuler & Ball, 1986; Ball, et al., 1988). Given this paucity of data, many questions have been left unanswered. This study addresses three of these questions: (a) Does target uncertainty affect older adults more adversely than younger adults?, (b) Does a recognizable pattern affect UFOV? and (c) What is the most effective training method to increase the UFOV?

Two experiments were conducted to answer these questions. In the first experiment, a reduced presentation field was designed to test the uncertainty question. Along with this reduction in the presentation, two patterns (organized pattern vs. unorganized pattern) were designed to test the effects of a restricted presentation pattern on the UFOV. These two reduced patterns were compared with the full field presentation. Although the UFOV, in general, was smaller for older participants than younger individuals, there was no effect for full field versus reduced field presentation nor an organized versus unorganized condition effect.

The second experiment addressed the efficacy of two training methods: full field or telescoping rings. The telescoping ring training method began with presenting the targets on the edge of the field. As the participant improved his/her performance in locating the targets, the presentation ring was moved outward. The full field presentation presented targets in a full 30° radius. Analyses indicated a significant relationship between training method and UFOV.

Specifically, both training methods were effective in increasing the UFOV. However, no significant difference between the two training methods was observed. Both training conditions increased the field size; however, individuals in the ringer condition were more willing to continue the training. This seems to demonstrate that the telescoping method may cause less frustration for the participants than the full field.

Chapter I

Introduction

Due to advances in medical care, current standards of living, and many other factors, people are living longer, more active lives than they were fifty years ago. In fact, by the turn of the century, 20 to 25% of all Americans will be 65 years old or greater (Mancil & Owsley, 1988). With the increase in the percentage of older individuals, more and more attention should be focused on the impact of aging on everyday activities. Specifically, finding ways to improve and maintain the quality of life for older individuals should be a priority.

One common age-related disability which is associated with a loss in mobility and independence is visual deterioration. Morgan, (1988) an optometrist, professor and visual specialist, reported several changes occurring in his vision throughout his life. For example, he noted that as he aged, reductions in blur sensitivity and pupil diameter size made it more difficult for him to detect small changes in a visual stimulus. Morgan also reported difficulty with acuity, visual search, glare, distinguishing shadowed areas in conditions of high contrast, color vision, and adapting to changes in light magnitude. Each of the previously mentioned changes are common among older adults and are some of the reasons that more attention should be focused on age-related visual variations. Another area of difficulty for him was the reduction of his visual field. Such a reduced field of view has specific implications for driving and maintaining mobility in later life. It is this finding that will be specifically investigated in this paper.

Chapter II

Literature Review

The visual field can be measured or defined in more than one way, and the size of the visual field is dependent upon the type of measurement used. One technique (dynamic perimetry) explores the borders, or isopters of the visual field as a small light is moved inward toward central vision. Another technique (static perimetry) measures the threshold for static light spots presented throughout the field. Still other tests assess peripheral sensitivity to more complex stimuli under more naturalistic conditions and obtain a measure of the working or functional visual field. Under some circumstances clinical measurements show less of a reduction in the field size as compared to functional measures. A prime example of this phenomena was reported by Morgan (1988) when he observed a reduction in his working visual field even though his clinically measured field remained stable. In fact, Morgan (1988) stated that:

> If I give my full attention to perceiving objects in the periphery, as in visual testing, my performance is excellent. But when my attention is divided, as in

> driving, I think that there has been a decrease in the size of my visual fields (p. 279).

Morgan explained how each of his observed visual changes affected his everyday activities. For example, difficulty in visual search resulted in an increase in the time needed to locate and identify objects such as signs, buildings or books. Glare and light adaptation problems made it more difficult for him to see in poor lighting or to adjust when coming out of buildings into bright streets. He also found it arduous to drive at night because of the glare produced by oncoming cars. Finally, his decrement in the functional visual field made it more difficult for him to perform tasks such as driving in which attention is divided. Drivers, in general, must be aware of many different factors such as speed, oncoming traffic, street signs, traffic signals and any possible pedestrians. This division of attention can severely restrict the functional visual field in some individuals and so, as Morgan pointed out, objects moving in from the periphery have to be closer to the center of the individual's visual field before they would be seen.

As noted previously, Morgan noticed that although his clinical visual field remained relatively unchanged, his working (or functional) field had decreased with age. Typically, if an older individual reports a change in visual field to an eye care specialist, a perimetry exam will be recommended. Usually, this will be a clinical visual field measurement. This clinical measurement is a topographical map of light sensitivity for a stationary eye (Verriest, 1983). Threshold measurements are obtained monocularly as the intensity of a light stimulus is varied for different locations throughout the visual field. The clinical visual field measurement is a static measurement and is designed to detect the onset of disease, neurological abnormality, or retinal disruption. Such an exam may not detect the basis for reported problems in an everyday situation, however.

In contrast, measures of the "Functional" or "Useful Field of View" (UFOV) are obtained binocularly, and provide a measure of the entire visual area in which practical information can be accumulated without eye or head movements (Ball et al., 1988). While the clinical measurements are used primarily for the diagnosis of disease, the functional visual field measurements are used to predict functional ability in natural conditions.

Although both of these measurement paradigms are useful, there is much more data on age-related changes in visual field as measured clinically than functionally. This difference in the amount of research may be because clinical measurements are older and more well developed than the newer functional measurements. Nonetheless, the results of most research, regardless of whether it is on the clinical or functional measurement, indicates that the visual field, in general, declines with age.

It should be noted however, that the amount of visual deterioration is not necessarily the same for each type of assessment or for all individuals within a given age group. Individual differences in both the size and sensitivity of the visual field occur no matter how it is evaluated. The following section reviews what has been found regarding age-related changes in peripheral vision using clinical measurements as assessed by standard perimetry.

Clinical Visual Field

One of the earliest studies examining aging effects on the clinical visual field was that of Burg (1968). Burg used a manual screening perimetry device to look at visual performance as a function of age and sex. He measured the lateral nasal and temporal visual fields of several thousand individuals. His results demonstrated that after approximately age 35, the visual field progressively decreases in size. These findings were consistent across all groups with one exception. After age 65, women displayed a significant increase in their nasal field. Burg's explanation for this phenomena was that because of the small sample of women in his study, there was not enough statistical power to detect false positives. As Burg pointed out, the knowledge of the occurrence of an age-related reduction of the visual field is important because of its effects on everyday activities, such as driving (Burg, 1967, 1968).

More recent studies assessing the visual field across age have found similar results (Jaffe, Alvarado & Juster, 1986; Breton & Phelps, 1986; Haas, Flammer & Schneider, 1986). Using an automated perimeter, each of these researchers tested first the right and then the left eye. They found a linear decline in the threshold sensitivity, volume, and surface area of the visual field as a function of age. They also discovered that peripheral field sensitivity decreases at a faster rate than central field sensitivity. In fact, threshold sensitivity decreases almost twice as fast at an eccentricity of 30° than at the central fixation point.

In a follow-up study, Johnson, Adams, Adams, and Lewis, (1988) attempted to determine the causes of these decreases in the perimetric areas. In this study, the researchers looked to see if pre-retinal, age-related changes in lens transmission and pupil size had an effect on the dimensions of the visual field. In order to minimize the influence of pupil size and lens transmission on field sensitivity, three testing conditions were used: (a) a Humphrey Field analyzer size III, white target on a white 10 cd/m^2 background; (b) a yellow on yellow visual field test of the same size and intensity; and (c) a yellow on yellow test with a size V target and 200 cd/m^2. The second test condition reduces the lens transmission effects because most age-related visual losses occur in the short wavelength section of the visible spectrum. The third condition alleviates both pupil size and lens transmission by increasing the size of the target and background luminance. The authors reported a decrease in the size of the visual field in all three conditions indicating that reduced pupil size and decreased lens transmission are not the basis for the age-related decline of visual sensitivity under photopic test conditions. Johnson et al. suggested that either retinal and/or post-retinal factors may account for the age-related decline in visual functioning.

Each of the previously mentioned studies measured the visual field in a clinical setting, necessitating a testing paradigm which minimizes uncertainty, distraction, and other factors common in the real world. Studies that have attempted to assess peripheral vision under more natural conditions will now be reviewed.

Functional Visual Field

As stated previously, functional vision or measures of the UFOV reflect the amount of information that can be obtained without any eye or head movements (Ball et al., 1988). There are several differences between clinical and functional measurements, and the two methods can thus be used to complement one another to provide different, important information about the patient's visual health. As discussed previously, clinical measurements are used for diagnosis of ocular diseases and are not necessarily predictive of the ability to function in the real world. Because of more complex targets and backgrounds, more uncertainty as to target location, and their much greater cognitive demands, functional measurements are more representative of the visual requirements in the real world than clinical measures, and are thus more likely predictive of real world performance.

Measurements of the UFOV have by and large been determined using the visual search paradigms developed in the study of attention. In this paradigm observers are required to detect, localize, identify, or recognize a specific target while sometimes attending to a secondary task as well.

Attention has been proposed to operate in two distinct modes: 1) an early preattentive mode where processing of the display is effortless and any target present is obvious (i. e., pops out) and 2) a later attentive mode where processing of the display requires a serial scan of each item for critical detailed information (Treisman & Gelade, 1980; Julesz & Papathomas, 1984; Bergen & Julesz, 1983; Nakayama & Silverman, 1984). It has been proposed that the first stage is useful for orienting one's attention to relevant information in the world and the second is used to examine specific items more closely.

Many variables influence the mode within which stimuli are processed. Since functional visual field measurements rely on visual search paradigms, and an understanding of the literature on visual search is crucial for using measures of the UFOV in diagnosis, the next section will review the relevant studies in this area.

Visual Search

One theory that distinguishes between preattentive and attentive processing is Treisman and Gelade's (1980) "Feature Integration" model. The "Feature Integration" model proposes that there are specific features which can be processed simultaneously, while combinations of those features must be addressed in a serial fashion. These features include color, motion, orientation, and size. By themselves, each of these features can be found preattentively if only one feature distinguishes a target. If two or more of these features are both relevant to distinguishing the target however, serial search is required.

In Treisman and Gelade's study, the participants were directed to locate a target embedded in a field of randomly placed distractors on a white card. In the feature condition the target was either a blue letter (T or X) or an

S (green or brown) which was embedded in a field of brown T's and green X's. In the conjunction condition, the target was a green T embedded in brown T's and green X's (both color and shape were in common with distractors).

A tachistoscope was used to present the stimuli. First a plain white card was presented. After a ready signal, the experimenter pressed a button which displayed a white card with a central fixation spot. After 1 second, the stimulus card was presented. The participant was directed to press, as quickly as possible, one key with their dominant hand if they detected the target, and another key with their non-dominant hand if no target was perceived. Reaction time was recorded to the nearest millisecond.

According to Treisman and Gelade's (1980) theory, parallel or preattentive processing is an orienting scheme while serial or attentive inspection is an identifying system. In this scheme, parallel search would be assumed if reaction time was constant with the number of distractors. Serial search would be assumed if as the number of distractors increased, reaction time increased as well. In other words, in the conjunction condition it was hypothesized that participants would have to attend to each letter separately in order to confirm its presence or absence (i. e. reaction time is linearly related to the number of distractors). The results confirmed the hypotheses. Reaction time was independent of the number of distractors if the target could be identified based on only color or shape alone (parallel search), but the number of distractors did have an effect if both features were required for target detection (serial search).

In a replication of one of Treisman, Sykes, and Gelade's (1977, cited in Egeth, Virzi, Garbart, 1984) earlier studies, Egeth et al. examined the effects of conjunctive features on visual processing. Their argument was that some conjunctive features could be processed in parallel. To review, conjunctive conditions are those in which two or more features are both relevant to target distinction for example, color and shape. Egeth et al. felt that the frequency of the distractors was confounded in Treisman and Gelade's (1977) earlier study. In their words, confounding occurs if the same number of both types of distractors are presented with the target (i. e. a red O embedded in seven black O's and seven red N's). This can cause the search pattern to be serial instead of parallel. Egeth el al. (1984) added an unconfounded condition that held constant the number of one of the distractors and varied the number of the other.

In their experiment they used two shapes, N's and O's and two colors, red and black. The target was a red O. The distractors were black O's and red N's. In the confounded condition, the number of distractors were equally divided if the target was present (in a display of 15: 7 red N's and 7 black O's). If the target was not present, one more randomly assigned distractor was added to the total. There were three display sizes utilized (5, 15, 25) and the same approach was employed for each display size.

For the unconfounded condition, there were always three red letters present and the number of black O's was varied from 2 to 22 to produce a display size of 5, 15, or 25. In both conditions, the participants were instructed to determine whether the target was absent or present and then locate it in the display. There were 72 trials for both the confounded and unconfounded conditions.

The results of this study indicated that reaction time was much slower in the "attend to red condition" when the target was absent than when the target was present. The results also indicated that the reaction time of the unconfounded condition was much faster than the confounded condition. This finding supports the hypothesis that some conjunction targets can be preattentively processed if the number of one of the distractors is held constant. The results were similar for the attend to "O" condition, also demonstrating a difference in processing for confounded and unconfounded conditions.

Steinman (1987) found comparable results using red and green lines as stimuli. Participants were instructed to detect either a single target (slanted lines) or conjunction target (non-slanted lines). In the conjunction task orientation and color were combined, for example, a slanted, red line. In addition to color, Steinman varied vernier offset, stereoscopic disparity, lateral separation (middle line centrally placed or displaced from the center), and orientation. The results indicated that reaction time to the single feature targets was much quicker than to the conjunction targets. This difference from the previous study could be explained by the fact that the distractors were confounded and, therefore, all conjunction target were processed serially (Egeth et al., 1984). It was also shown that the reaction time to the conjunction targets varied depending on which features were combined. For example, when lateral separation and orientation features were presented together reaction time was much slower than when either of these features were presented separately. However, vernier and stereopsis conjunction targets produced much faster reaction times with a relatively flat slope, than the lateral separation and orientation targets, which were not only faster but also had a more positive slope. These findings were interpreted as demonstrating that some conjunction features can be processed preattentively, and with an increase in the display size move to a more attentive process. However, the researchers did not vary the number of distractors (unconfounded condition); therefore, these results are not conclusive.

Pashler (1987) performed several experiments assessing the effects of color and form conjunctions on visual search. In his first experiment, participant's were instructed to detect the presence or absence of a green T amongst green O's and red T's. The difference in this study from Egeth's et al. (1984) is that all distractors were what Egeth called confounded. Pashler's results indicated that the response time for the present condition was much faster than for the absent condition. In the second experiment, Pashler manipulated presence/absence and the display size. The task was essentially the same except for these changes. The results were similar to the first experiment. Reaction time in the present condition was much faster than in the absent condition. Reaction time was also faster for smaller displays. In both these experiments the slope was positively related to display size. Therefore, it seems that the greater the number of distractors, the slower the reaction time.

The third experiment in Pashler's study was a replication of Egeth et al.'s (1984) second experiment which was described previously. The only difference between the experiments was that the display size was varied from 2 to 24 items instead of 5 to 25 items as in Egeth et al.'s study. As was expected, the results were comparable to Egeth et al.'s findings. Again slopes were positively related to display size, indicating that distractor frequency may have an effect on reaction time.

The results of these experiments do not support the idea of a serial search pattern for all conjunctive targets. They do in fact seem to support the idea that some conjunctive features can be and are searched preattentively.

In summary, attention is divided into two types: serial and parallel. Parallel processing occurs when information is processed simultaneously and serial processing occurs when each element is processed individually. Earlier it was demonstrated that several factors affect how information is processed. Among these are color, shape, number of distractors, and combinations of features. Several studies have found results indicating that distractor frequency does indeed have an effect on the type of processing used (Egeth, et al, 1984; Nakayama & Silverman, 1986; Steinman, 1987). It has also been established that certain combinations of these features can affect the type of processing used as well (Egeth et al., 1984).

As stated previously, UFOV measures can be assessed using either an attentive or preattentive task. The following sections will review the research on the UFOV as reflected through serial and parallel processing in measuring the UFOV.

Serial Processing

There have been several studies which have examined serial search across age groups in order to infer the UFOV. One of these, Scialfa, Kline and Lyman (1987), evaluated the UFOV with an identification paradigm. Subjects were instructed to identify a target (either a T or an O) embedded in a varying number of distractors (0, 2, or 19). The target was presented at one of five eccentricities ranging from 0° to 10°. First of all, results indicated a slower response rate in identifying the target for older adults when compared to younger adults. Secondly, older individuals were adversely affected by noise and target location relative to younger observers (Scialfa, Kline, Lyman, 1987). Across all age groups, the more eccentric the target, the greater the response time. The older observers, nevertheless, were more greatly affected than the younger observers such that increased eccentricity and distractors slowed the reaction time for older adults more than younger adults. Serial processing has been hypothesized to affect older individuals more because of a slower processing speed and possible changes in short-term memory which younger individuals do not usually have. Therefore, a slower reaction time would compound the problem as the number of distractors increased.

As with response time, the identification error rate was also greatest with peripheral targets embedded in distractors. The authors explained these deficits as a result of a reduction in the size of the UFOV. They proposed that older participants take smaller perceptual samples in their serial search, and that it takes them longer to process each sample. Furthermore, the younger participants seem to tolerate noise much better than older adults.

Plude and Doussard-Roosevelt (1987) proposed that age-related visual deficits in serial processing are a result of a decrease in the UFOV rather than deficits in selective attention. The participants in their study were asked to identify the location of a target in one of 36 locations ranging from a central position to 25° of eccentricity. Three conditions were manipulated (feature, unconfounded, or combination), in addition to display size (5, 15, or 25 elements), and probe (target present or absent). In the feature condition, individuals were asked to identity a target on the basis of one feature, either color or form. The combination (or conjunction) condition directed the individuals to identify the targets on the basis of both color and form. For example, to find a "red circle" in a field of red and green triangles. Finally, in the unconfounded condition the number of distractors sharing the same color as the target was held constant regardless of display size. As before, the display size referred to the number of elements on the screen, not the physical size of the screen. The results demonstrated that the eccentricity of the target interacted with the condition of the stimuli (feature, unconfounded, or combination). When the target was embedded in noise there was a longer reaction time and a higher error rate. A significant interaction between age and eccentricity was also found. Thus, the older an individual is the more likely she/he is to have trouble identifying information farther into the periphery.

Plude and Doussard-Roosevelt (1987) actually tested both the serial and parallel search paradigms. Their feature detection condition meets the criterion for parallel search while the unconfounded and combination (or conjunction) conditions required serial search. Like may other researchers (Ball, et al., 1988, Scialfa, Kline & Lyman, 1987), Plude and Doussard-Roosevelt have reported an age effect for reaction time. In detail, as age increases, reaction time slows. However, the results also indicated an interaction between age and condition. Specifically, the combination and unconfounded conditions affected older individuals more adversely than younger participants. In other words, the older individuals show a slowing in reaction time related to combination condition, indicating a deficit in both serial and parallel processing.

The preceding section reviewed the literature on serial processing and how it is related to the UFOV. The following section will review work that has examined parallel processing, specifically that which demonstrates age effects on the UFOV.

Parallel Processing

One of the first studies to evaluate the functional FOV in a parallel search task for young versus older participants used a radial localization task (Sekuler & Ball, 1986). Observers were asked to localize a schematic face presented in the periphery at three eccentricities (5°, 10°, and 15°) while they performed a concurrent central task. This was not a reaction time study as were the preceding experiments. The authors reported that the presence of distractors and a central task had a greater impact on the performance of older adults than younger adults. They also found that distractors had a greater effect on performance than the central task. More errors were made when distractors were present without a central task than when the central task was presented without distractors, and the greater the eccentricity, the larger the error rate for older participants as compared to younger participants. This age X eccentricity interaction indicated that the size of the UFOV was smaller for older individuals, in general, than for younger adults.

In a second phase of their study, several of the older participants practiced the peripheral localization task for four additional days. The results indicated that practice decreased the error rate for all three eccentricities. It did not however, totally eliminate the increased error rate of the older observers (Sekuler & Ball, 1986). Thus age-related constriction of the UFOV can be partially compensated for by training. Retesting after a period of 3 to 5 weeks also revealed retention of training.

Another study (Ball et al., 1988), varied levels of center task demand, number of distractors, and type of stimuli used in training for an even greater range of eccentricities and for <u>three</u> age groups (i. e. young, middle-aged, older). For older individuals, a high-demand center task was found to cause significantly more errors in peripheral localization than a task of lower difficulty and the center task had a greater effect on the more peripheral targets than the more central ones.

The researchers then looked to see if the number of distractors affected the UFOV. They discovered that reducing the number of distractors did not significantly reduce the error rates. Stated another way, they found that increased eccentricity produced a greater number of errors in peripheral localization regardless of the number of distractors. These findings confirm that the display was processed in parallel. If the display had been processed serially, the number of distractors would have affected the error rate.

The results of the Ball et al. (1988) study also indicated that there was a restriction of the UFOV for the older participants as demonstrated by the eccentricity X age interaction. Significant center task X age X eccentricity and distractors X age X eccentricity interactions also demonstrated that the effects of these variables were significantly greater for the older adults than for the younger adults.

As in the previous study, practice was found to be effective in reducing the number of errors across the medium and high difficulty tasks. Indeed, before practice, the error rate of the young participants at 30° was comparable to the middle aged's average error rate at 20° and the older participant's average at 10°. In other words, the function relating average error rate to eccentricity shifted by 10° for each age group. While practice was found to decrease the number of errors across all participants, it did not make the older participants scores at 30° analogous to those of the younger or middle aged at the same eccentricity (Ball et al., 1988).

It should be remembered that one of the factors being assessed in this study was the retention of practice over time. In order to assess this, the researchers retested the participants on posttraining conditions over a six month period at 1 month intervals. Analysis revealed that improvement of performance did persist over this time period indicating adequate retention of training.

Cerella, Plude, and Milberg (1987) used a slightly different approach to the functional field problem. In this study participants were instructed to move a cursor to the location where they had perceived the target on a computer screen. Their results revealed that the younger participants were more accurate in placing the cursor than the older participants. In fact, the younger participants were 41% more accurate than the older participants. The researchers postulated that the difference could be caused by several factors. One factor might be that the elderly forgot the point more quickly than the younger individuals. To test this hypothesis, the researchers looked to see if there was a difference in accuracy in relation to the separation between the target and cursor. They found that there was no difference in accuracy regardless of the distance of the cursor from the target.

A second hypothesis tested was that the older participants may have been less precise in positioning the cursor, but perceived the target position accurately. To test this hypothesis, the researchers tested additional young and older participants on a similar task. In this task, the participant had one chance to stop a moving cursor on a stationary target. If there was an age difference in positioning accuracy it would be indicated by this experiment. Results indicated that there was no significant difference in positioning precision between the two age groups.

As indicated by the literature reviewed above, there is substantial evidence that the size of the UFOV decreases with age. There are many ways in which this reduction could affect the quality of life of an older person. For example, an older individual would have more trouble with any activity relying on peripheral vision such as walking down the street or driving. If the UFOV is reduced, then the individual would have to spend more time scanning the same visual area and more time fixating in each area in order to receive the same amount of information as an individual with a larger field. It would also mean that more information would be missed or not perceived early enough for the individual to react and objects might suddenly appear in the central visual field without warning. Even though it may seem obvious that restriction of the UFOV would affect driving performance, there has not as yet been a direct test of this relationship. There is, however, substantial information about the older driver which appears to be relevant to the UFOV.

Older Drivers

More traffic convictions, accidents, and deaths per mile driven occur for older drivers than for any other age group (Planek, 1973; Williams, & Carsten, 1989; Transportation Research Board, 1988). An examination of the types of accidents common to the older driver shows that older drivers are more likely to fail to see signs, yield to traffic, turn safely, and have have more intersection accidents (Ball, Owsley & Beard, in press). Older drivers are also more likely to be involved in two car accidents than their young or middle-aged counterparts (Campbell, 1966). All of these types of accidents represent "failure to see" situations rather than speeding or intoxication which are more frequent in a younger age group. Additionally, older individuals are more likely to be killed or injured in automobile accidents (Mackay, 1988).

Kline (1986) argued that over 90% of all the information used while driving is obtained from visual reference, and that although good visual acuity may not be necessary, it is beneficial to safe driving performance. Kline stated that driving consists of a multitude of parallel and sequential processes obtained from various visual functions. Some of these same processes influence visual search and the size of the UFOV.

Most of the research attempting to associate visual processes and driving performance has failed to demonstrate strong relationships (Hills, 1980; Burg, 1968; Ball et al., 1988; Hills & Burg, 1977; Kline, 1896). Hills correlated static and dynamic visual acuity, glare recovery, low-light threshold recognition and phoria (the degree that two eyes do not line up) with accident rate. He found no relationship between any of these visual factors and accident rate. Other studies that have investigated the relationship between driving performance and visual field loss have also shown no significant relationship (Burg, 1967; 1968; Council & Allen, 1974; and Shinar, 1977). However, several more recent studies contradict these findings.

One study reported a link between poor visual acuity and accident rate (Hofstetter, 1976). Hofstetter's analysis of clinical measurement of visual acuity indicated that there is a correlation between age and visual acuity and a subsequent correlation between visual acuity and accident rate. However, there are several limitations to this study. Hofstetter did not examine the performance of older individuals with good acuity versus the same aged individuals with poor acuity. Since older individuals have more accidents, and also tend to have poorer acuity, a better approach would be to match observers on age and then examine the relationship of acuity to accident rate. Furthermore, Hofstetter did not control for the number of miles driven by each individual. This further limits his study from looking at the basis of age-related accidents based on the large variability in exposure. Essentially, his results indicated that older drivers as a group have poor acuity and more accidents than younger individuals. Other studies have shown that older individuals drive fewer miles than younger individuals and that if the number of miles driven is controlled for, accident rate is inflated for older individuals (Kline, 1986; Kosnik & Sekuler, 1989).

In another study, Avolio, Kroeck, and Panek (1985) used a group embedded figures test to measure "visual noise" in addition to auditory noise in relation to accident rate. Three types of selective attention were investigated: omission errors (failure to inform about the presence of the target), intrusion errors (relating an incorrect target), or switching, (failure to report target correctly after change in attention). They found that selective attention on omission and switching errors were significantly related to the number of accidents. The researchers also found that the visual and auditory selective attention predictors were highly intercorrelated ($r=.50$, $p<.001$) and that the greater the effect of distraction, the greater the number of driving accidents. Other variables such as sex, age, the average number of miles driven daily, and job tenure as a driver were not significantly correlated with the number of driving accidents.

Another study (Johnson & Keltner, 1983) found a significant relationship between clinical visual field deficits and driving. They found that the visual field shrinks with age but that this shrinkage is slight up until age 50, then becomes more profound. They also found that there is more inter-rater variability of the field size for people over 60. They reported that monocular field reduction does not have a significant effect on driving performance, but that binocular visual field deficits have a serious effect on driving performance. However, it should be pointed out that only .3% of 10,000 people have severe binocular deficits, and this is where the driving relationship occurred. Finally, their results demonstrated that almost 60% of all individuals who have a visual field deficit are not aware of this complication.

In investigating the relationships between visual fields measured with the Goldman static perimeter, the Octopus automated perimeter and the UFOV paradigm, Ball, Owsley, and Beard (in press) found that age is related to each measurement technique. Still, when age is partialed out, the UFOV becomes the most significant predictor of reported problems in peripheral vision on a visual activities questionnaire. In other words, while older participants show a decline in the visual field as measured by the Goldman, Octopus and UFOV procedures, the UFOV paradigm is the best predictor of reported problems in everyday activities, such as driving. This is most likely because the UFOV paradigm is more true to life than the Goldman and Octopus measures. It include distractors, divided attention, and uncertainty which are all components of situations in the real world. A relationship between UFOV and driving performance most likely has not been found because measurements of visual sensitivity are not made under conditions similar to a driving environment (Ball, et al., in press).

Given that a relationship can be demonstrated between the size of the UFOV and accident rate it will be crucial to develop appropriate interventions for those individuals with reduced function. As described already, Sekuler and Ball (1986) and Ball et al. (1988) are the only two studies that have looked at the training effects in the UFOV. While these studies did provide evidence that training does increase the field size, several questions remained unanswered. The researchers had participants practice on the same conditions used for assessment. This paradigm may not be the most expeditious for the simple reason that given a small UFOV many of the trials would be presented in a relatively insensitive area of the field. It could be that a more focussed presentation of trials in the area just outside the boundaries of the UFOV would be of more benefit. Specifically, would a task that presents the target on the edge of the individual's field, that moves outward with improving performance, be more effective than a task presenting targets throughout the entire field?

Chapter III

Experiment 1

In order to test the hypothesis that stimulus presentation on the outer rim of the UFOV might be more effective in training than a random full field presentation, it was necessary to reduce the number of potential targets to fall in a more restricted range. Since this reduced the uncertainty as to target location, we first wished to determine what effect this would have on performance, and whether or not the effect would be the same for all ages. It was suspected that there might be an age effect for uncertainty, specifically, that the uncertainty of where the target might appear would have more of an effect on older individuals than younger individuals. To test this hypothesis, two reduced uncertainty conditions were produced (one with a recognizable pattern and one with a random pattern and compared with the entire field presentation used in previous studies).

Method

Subjects

The subjects were 18 adults who ranged in age from 19 to 80 years. These participants were classified into three age groups: Young (19-39), Middle (40-59), and Old (60-80), with six participants in each age group. Each of the participants had a valid drivers license and 20/20 corrected vision.

Recruitment consisted of phone solicitation of naive older and middle-aged individuals and solicitation of younger participants from classes at WKU. In addition to the monetary compensation that all participants received, those participants recruited from the classroom received extra credit points from their instructors.

Materials

A screening interview was conducted to assess the participants' visual and driving qualifications. Participants completed a subject information sheet (See Appendix A) and a consent form (See Appendix B) at the time of the screening interview. The subject information sheet determined the ocular history of the individual. Any individual who reported the presence of any ocular disease, other than refractive error was not included in the study. At the same time, the subject was also given a brief description of the study and told what would be required of him/her.

A quick evaluation of each participant's visual acuity was conducted using the Bailey-Lovie Distance Chart and the Bailey-Lovie Near Chart. The Bailey-Lovie Distance Chart measures the visual acuity of the individual from a distance of three meters. The Near Chart was used to attain acuity measures for distances under one meter. If refractive correction was needed for best acuity, then corrective lens were worn during the experiment.

The participants were then asked to complete two written questionnaires (See Appendix C) dealing with everyday visual encounters and driving behavior. These questionnaires were part of a validation study of the UFOV, and the data from these questionnaires will not be reported in this paper.

An Apple IIe personal computer was used to run the programs that presented the experimental conditions. A 23" Conrac monitor was attached to the computer. This provided a screen large enough to present stimuli up to a 30° eccentricity in the visual field. A modified keypad was used to record the participants' responses.

Procedure

The UFOV task was first demonstrated to the observer using a picture representation. The participant was then seated with his/her head positioned in a chin rest 28.5 cm from the display to center the eyes on the screen. From this distance, one degree of visual angle corresponded to one cm on the CRT screen. After being seated, the participant was given a set of practice trials at a very slow presentation speed. Four to 24 practice trials were presented with the number determined by when the participant felt comfortable with the task.

Each trial presentation consisted of four stages: 1) The first stage presented a center fixation box of 8 x 9 degrees for one second. 2) A brief stimulus was presented (86.5 msec) consisting of both a center stimulus (a schematic face) and a peripheral stimulus which was embedded in a field of distractors. The distractor stimuli consisted of 48 outlined boxes appearing in concentric circles around the fixation box. The peripheral target, a schematic face, could appear in any of 24 possible positions which fell on a circular radial pattern divided into eight spokes (four in a cardinal orientation and four in an oblique orientation) at one of the three eccentricities (10°, 20°, 30° degrees). 3) A spatially random masking pattern was presented for one second to prevent further processing. 4) Finally, a radial pattern appeared with 8 spokes which were labeled 1 through 8, and corresponded to the number layout of a keypad in front of the observer. The subject recorded all responses via the keypad.

The subject was presented with two tasks to complete in each trial. These were the center and peripheral tasks. The center task was used to ensure that the observer was fixating on the center of the screen and not scanning the area. The subject was asked to indicate whether the center stimulus, a schematic face, was present or absent. He/she did so by pressing keys labeled "P" for the presence of the cartoon face or "A" for the absence of the face. Computer generated tones provided the subject with immediate feedback about the correctness of each response. If the correct response was given for the center task, the peripheral response was required. However, if the subject did not answer the center task correctly, the program did not require a response for the peripheral task and the trial was recirculated into the stack to be presented again at a later time. The peripheral task involved identifying the location of an additional schematic face in one of 24 possible locations in the periphery. These locations coincided with the eight spokes at either 10°, 20°, or 30° of eccentricity. The participant was to respond by pressing the number on the keypad that corresponded to the spoke along which the stimulus appeared.

Each participant was asked to participate in one session in which three blocks of trials were presented. Each block contained 24 trials representing the random occurrence of the face target at each of the 24 possible positions.

Three experimental conditions were used in this investigation. In one condition, the targets were presented in a full field 24 target pattern as described above. The second and third conditions employed the same presentation pattern with the exception that there were a reduced number of possible positions. While a reduced number of positions was possible for these two conditions, the same number of presentations were given. In the second condition the possible positions formed a recognizable diamond pattern (See Appendix D) and the third condition was a random presentation pattern (See Appendix E). By utilizing a Latin Square design to assign participants to experimental conditions, counterbalancing was attained for each subject. This design was used in order to distribute any practice effects evenly across conditions.

Results

The participants' responses were reported as the number of correct localizations for each eccentricity. These responses were then converted to field sizes using a regression equation. A linear regression equation between eccentricity and the number of correct localizations was generated for each subject. Using this equation, the eccentricity at which the subject could detect the peripheral target 50% of the time was calculated. This eccentricity constituted the border of the individuals'

UFOV. If an individual had fewer than 50% correct on all three eccentricities, then the minimum field size, 5°, was assigned. If the individual had more than 50% correct responses for all three eccentricities then the maximum field size plus 5° (35°) was assigned. These UFOV measures were analyzed for age and pattern effects. A two way ANOVA revealed only an age effect for field size (see Table 1). As can be seen by an inspection of the means, UFOV decreases with age (see Table 2).

Table 1. ANOVA of UFOV by Age and Pattern (Experiment 1)

Source	Sums of Squares	df	Mean Squares	F	Sign. of F
Between *S*'s	1980.21	17	116.48		
Age	1187.22	2	593.61	11.23	.001
Error	792.99	15	52.87		
Within *S*'s	960.53	36	26.68		
Pattern	133.23	2	66.62	2.78	N.S.
Age X Pattern	107.74	4	26.93	1.12	N.S.
Ss(A) X Pattern	719.56	30	23.99		
Total	3023.44	53	57.05		

Table 2. Means and Standard Deviations of UFOV by Age (Experiment 1)

	Young	Middle	Old
UFOV			
M	19.93	12.98	8.60
SD	5.09	6.65	6.26

Discussion

As expected, an age-related change was found for the UFOV. Previous research has found that in general, the UFOV shrinks with age (Ball et al., 1988).

The various patterns did not significantly affect the field size as either a main effect or as part of an interaction. These results demonstrate, once again, that the UFOV task is parallel in nature. If one or both of the pattern conditions had revealed significantly different field sizes, then that would suggest that one of the conditions might have been processed serially.

These results could also indicate that uncertainty of target location does not affect field size. However, this is not conclusive. It could be that reducing the target presentation area to ten possible positions is not effective because the uncertainty effect has already been eliminated. In other words, 24 possible target locations is not enough to cause uncertainty effects either. Or it could be that uncertainty has no effect on preattentive or parallel tasks.

Chapter IV

Experiment 2

If a relationship between the UFOV and driving can be established, then it will be critical to provide some means of improving UFOV performance and determining if it enhances the same behavior. As mentioned earlier, previous training studies demonstrated the plasticity of the UFOV and the present study is an attempt to develop even more expedient methods of training. It was hypothesized that a training method that initially presents targets on the border of the UFOV and then moves the targets farther into the periphery with improvement in performance (50% localization errors) might be more effective than just a random full field presentation. The second study compared these two presentation techniques.

Method

Subjects

Thirty-six naive participants were recruited for this experiment using the same criteria as in the first experiment. Participants were assigned to one of two training conditions. At the time of recruitment, each subject was told that he/she would be required to attend several sessions and would be paid for their participation time. Each was also informed that the first session would last approximately 45 minutes and all remaining sessions would last no more than 20 minutes. When a subject verbally agreed to participate, he/she was then scheduled for a first appointment.

Materials

The same materials and apparati were used as in Experiment One.

Procedure

During the first session the participants were asked to complete all the necessary forms and questionnaires. Then the participants were given a complete explanation of the procedure and required tasks. (The task was the same as the full field task described previously.) They were then given a chance to orient themselves to the task at a very slow duration. The duration for this orientation depended upon the age of the individual. If the participant was in the young category, they practiced at a duration of 69.4 msec per trial. However, the middle and old adults practiced at 138.8 msec per trial. After the participants indicated to understand the task, the procedure was continued at a faster speed, 52.08 msec for the young participants and 121.52 msec for the middle and old participants. After completing this block of trials a UFOV measure was computed using the same regression procedure described in the first experiment.

Field Size Matching. In order to equate performance prior to beginning the training phase of the study, the duration which corresponded to a UFOV of 10° was obtained for each observer. This was accomplished by adjusting by 20 msec after each block of trials until a field size of 10° was achieved. For example, if the field size was 20° then the target presentation duration was decreased by 20 msec, but if the field size was 5°, the duration was increased by 20 msec. This procedure was continued until a UFOV of 10° was attained. Once a 10° field size was attained the participants were scheduled for their next session. It should be noted however that the UFOV was limited by the machine. Specifically, several younger individuals had UFOV's greater than 10° because duration could not be increased to a speed that effectively decreased the field size to 10°. All subsequent training, regardless of condition, remained at the presentation speed determined in this portion of the procedure.

Training. At the second session each participant was randomly assigned to one of the two experimental conditions: "full field" or "ringer". In the full field condition targets were presented at each of the 24 possible positions, as described previously. Each subject completed four blocks of trials per session.

The ringer condition used a training method that utilized a telescoping strategy. The participants were still asked to fixate on a center fixation box and then to localize a peripheral target. The difference from the full field design was that the peripheral targets occurred initially at a 10° eccentricity. Once the participants attained a 75% correct localization criterion for two consecutive blocks, the peripheral targets were moved to 20° eccentricity. After achieving the 75% criterion twice in a row again, the targets were moved to 30°. Distractors were presented in all 48 positions for full field condition filling each of the three rings (10°, 20° and 30°) except for the target position. As for the ringer condition, the distractors were placed in the same positions as in the full field condition. The only difference between the two conditions was the number and placement of possible targets.

In both conditions, if the subject did not continue to improve for three days, they were considered to have stabilized and were discontinued. Specifically, if the participant's field size fluctuated 1° around a single field size for three days, the cutoff was considered achieved.

Field Size Matching. As discussed previously, the participants number of correct localizations were converted into UFOV measures using a regression equation. In order to assure that each age group started at the same level of performance across training conditions, tests of significance between the starting field sizes and duration were performed. These t-tests indicated that no significant differences existed between the training conditions' starting field sizes (all $t's(6) < 1.65$, $p > .05$) or duration speeds (all $t's(6) < 1.34$, $p > .05$). The means and standard deviations for these are presented in Table 3 and Table 4.

Table 3. *Means and Standard Deviations for Starting UFOV's (Experiment 2)*

	Young	*Middle*	*Old*
Ringer			
M	14.73	11.28	10.93
SD	8.28	2.17	1.13
Full Field			
M	13.30	11.23	12.82
SD	3.69	3.87	1.87

Table 4. Means and Standard Deviations for Starting Durations in msec (Experiment 2)

	Young	Middle	Old
Ringer			
M	33.38	85.00	143.75
SD	45.13	42.75	82.63
Full Field			
M	12.50	80.38	162.50
SD	0.00	73.25	85.75

Training. For the full field condition, UFOV sizes were computed using the same regression procedure as described in experiment one. In the ringer condition, a linear regression equation between the number of correct responses and eccentricity was calculated. This regression was not performed until all the data were collected. At that time, the UFOV was calculated. For the ten degree ring, if performance was less than 50%, UFOV was set at 5°. If performance was beyond 50% correct, a two point linear regression using actual performance at 10° and chance performance at 20° was used to calculate the UFOV. Once the subject's performance exceeded the 75% criterion at the 10° ring, the subject was switched to targets at 20°. In this case, the UFOV was calculated using final performance on the ten degree ring, actual performance on the twenty degree ring and chance performance on the thirty degree ring. Finally, when the subject had been switched to the thirty degree ring, final performance at ten and twenty degree rings and actual performance on the thirty degree ring were used to calculated the UFOV. Figures 1 through 3 show the full field and ringer field sizes plotted for the number of training days for each age group.

The slopes of these training lines (see Table 5) indicated that training did increase the field size across all three age groups. As can be seen from Table 5 the confidence interval of the slopes did not include zero. However, an ANOVA was performed to determined whether significant effects occurred between the training conditions (see Table 6).

Table 5. Average Slopes, Standard Deviations and Standard Errors for Training Effect Across Number of Days for Each Age

	Young	Middle	Old
Ringer $\bar{X}$	.740	.911	1.064
s	(.382)	(1.05)	(.746)
$s_{\bar{x}}$	(.156)	(.470)	(.373)
Full Field $\bar{X}$	.742	1.004	1.089
s	(.306)	(.808)	(.919)
$s_{\bar{x}}$	(.125)	(.305)	(.411)

To summarize, both training conditions were effective for each age group. But, no significant differences in the slopes between conditions were found indicating that one training method was more effective than the other.

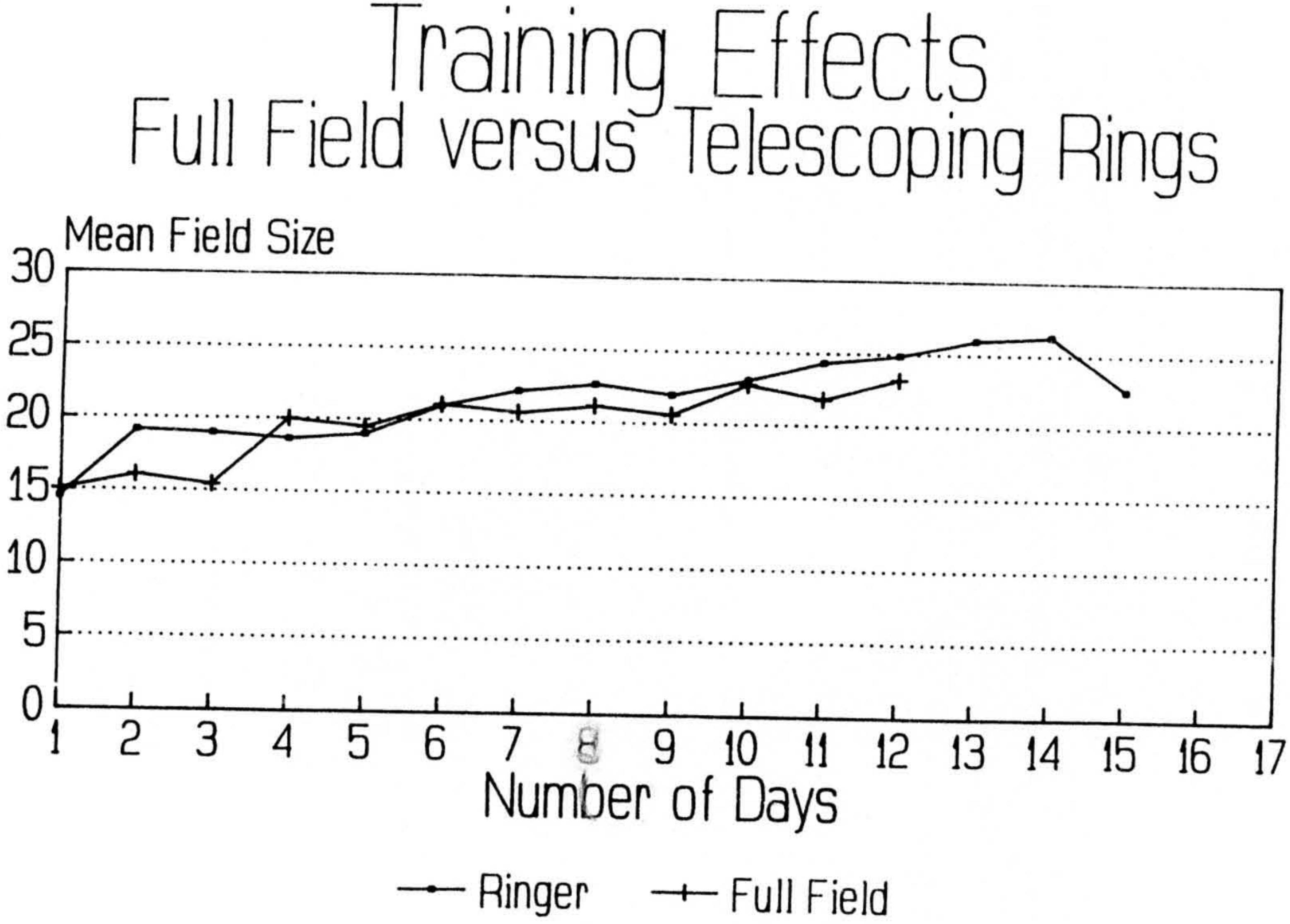

Figure 1. Field size across number of days as a function of training method for younger adults.

Training Effects
Full Field versus Telescoping Rings

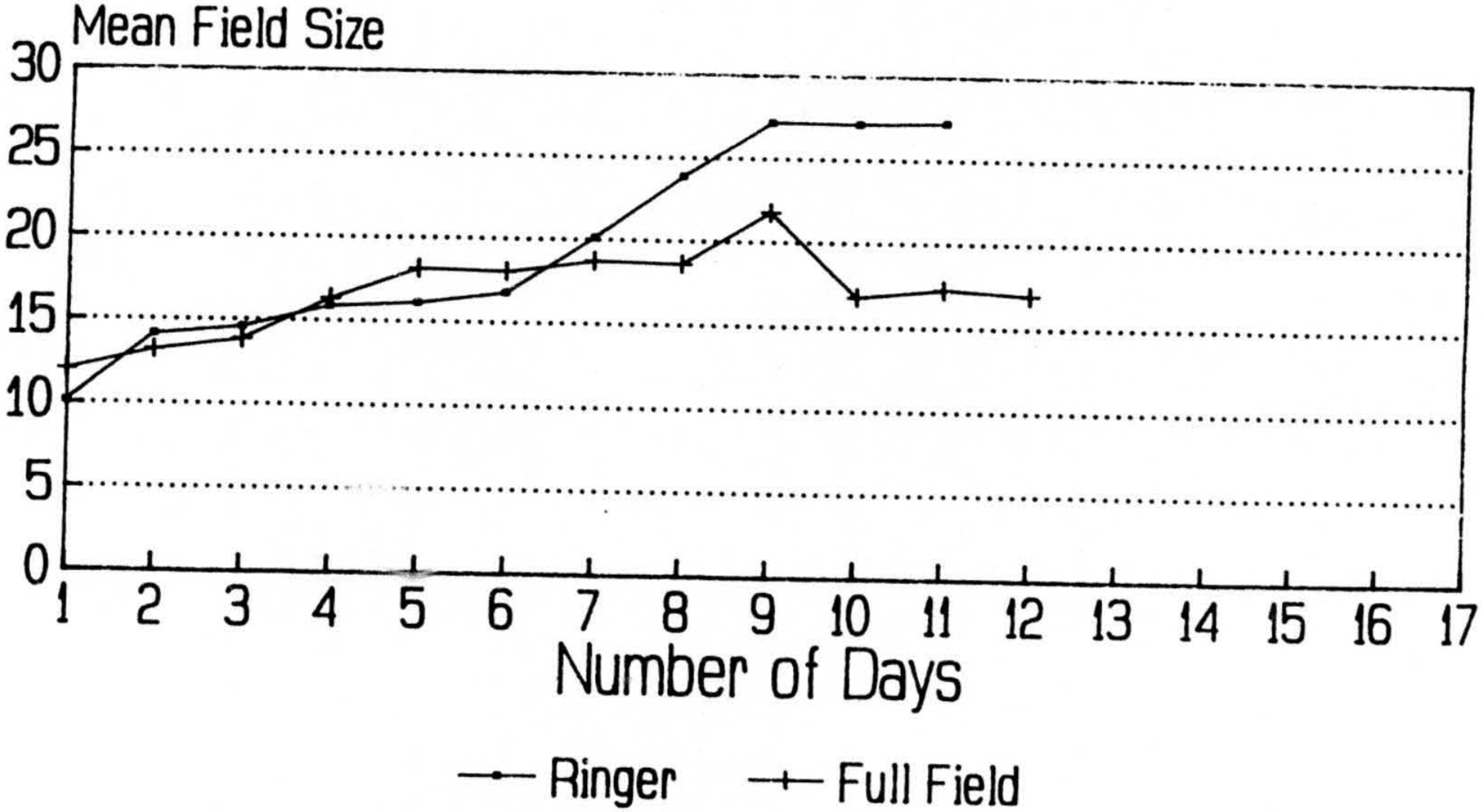

Figure 2. Field size across number of days as a function of training method for middle-aged adults.

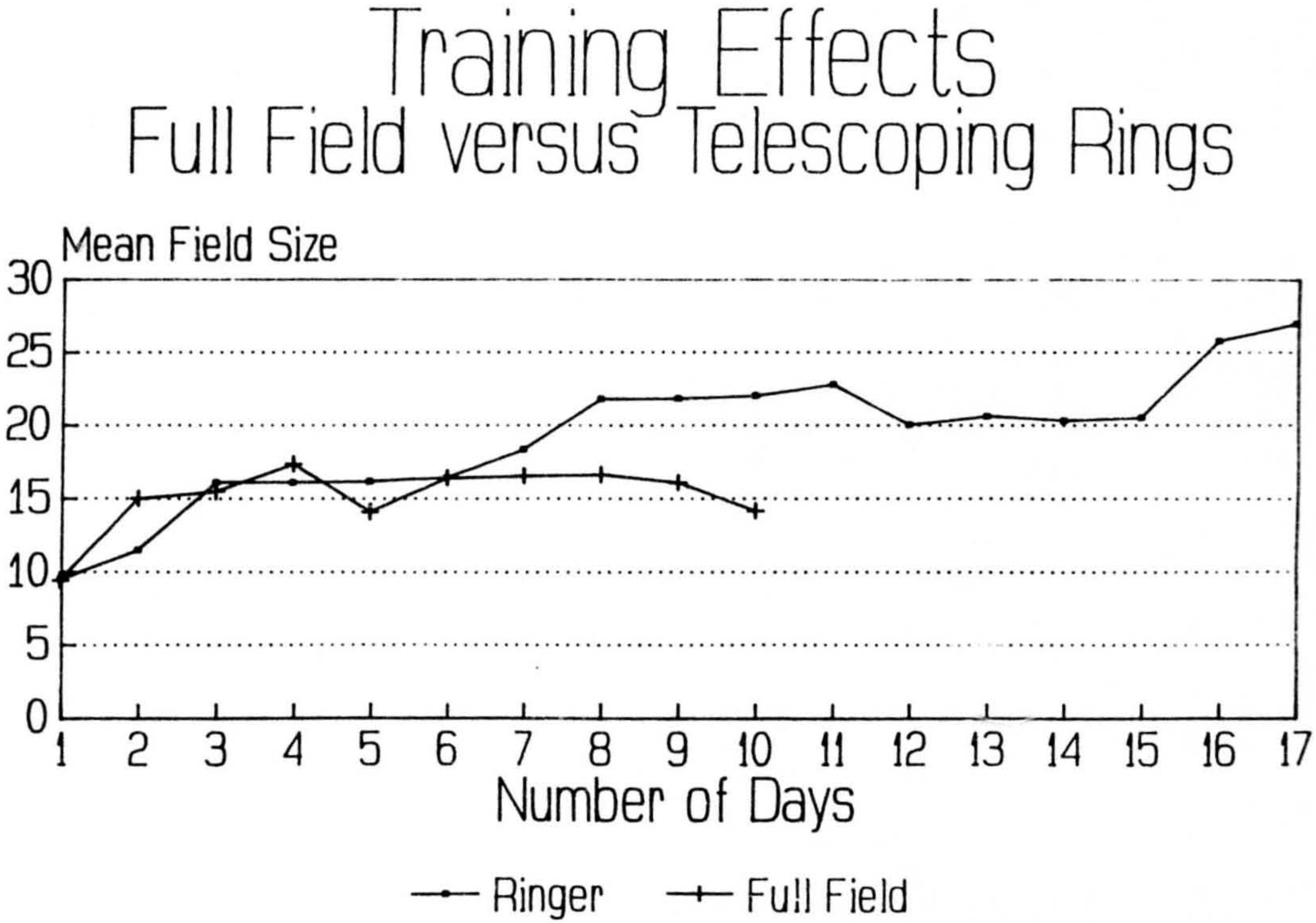

Figure 3. Field size across number of days as a function of training method for older adults.

Table 6. Anova of the Slopes by Training Method and Age (Experiment 2)

Source	Sums of Squares	df	Mean Squares	F	Sign. of F
Training Method	0.003	1	0.003	0.007	N.S.
Age	1.640	2	0.820	2.294	N.S.
Method X Age	0.237	2	0.118	0.331	N.S.
Residual	8.578	24	0.357		
Total	10.470	29	0.361		

Discussion

The results of these analyses indicated that training does increase the field size, as the literature indicated (Sekuler & Ball, 1986). Because no significant differences were found between training conditions, it seems that at first glance both training methods are equally effective. However, when looking at the plots of the training effects, it is revealed that ringer might have some training advantage over the full field method. A possible advantage of the telescoping methodology is that participants seem to become less frustrated with the task and are more willing to continue the training sessions for a longer period of time. One possible reason for this could be that the participants receive more positive feedback with the ringer condition than the full field. Also, when the participant achieves the 75% criterion, he/she is moved to the next ring. This may cause the individual to perceive a greater improvement in the field size than with the full field condition. While there are no data to support this supposition, it seems that this would be a good area for further research.

[redacted]

Chapter V

Conclusions

In conclusion, it appears that while the UFOV shrinks with age, the effects of uncertainty are not a factor in this shrinkage. It also appears that the UFOV can be increased with training but that it does not matter how training occurs. However, the telescoping training method does seem to have a few advantages for the full field method as discussed previously. If the UFOV is related to everyday activities as the literature suggests, then the problems that older individuals report need not be debilitating (Johnson & Keltner, 1983; Ball, Owsley & Beard, in press).

One possible reason for the lack of a significant difference in the training conditions could be the variability within the age groups. Each age group has a great deal of inter-rater variability in performance of the UFOV tasks. To express it another way, some young individuals have very small UFOV's (10° or worse) and some older individuals have very large UFOV's (30° or better). It could be that some other factor, other than age, is the moderating factor for performance (i. e., duration). Further research needs to endeavor to explore these other factors' relationship to training methods' effectiveness. It could be that one training method is effective over the other for a particular group, for example, older individuals with small UFOV's at a very slow duration.

It is possible to increase the UFOV through training. Therefore, those older individuals Who report problems in everyday activities might be able to improve their performance through training of the UFOV. This could have other advantages in allowing the DMV and insurance companies to give incentives to older drivers in exchange for training of the UFOV.

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Appendix A

Subject Information Sheet

Subject Information

Name ____________________

Address ____________________

____

____

Date ____________

Age ____________

Phone ____________

Medical History

List all Medications ____________________

List all Major Illnesses ____________________

Visual History *(Circle Appropriate Answer)*

Cataracts Yes No

Diabetes Yes No

Any other Visual Illnesses Yes No ____________________

Macular Degeneration Yes No

Glaucoma Yes No

Personal History

Do you have a valid Driver's license? Yes No

List your license plate number ____________

List the name of your Ophthalmologist ____________________

Date of last eye exam ________

Visual Complaints ____________

Please list your Occupation ____________________

Please list any other experiments you have participated in:

____________________ Date ________

____________________ Date ________

Any other comments: ____________________

____

____

Correction

Pelli-Robson Contrast Sensitivity ____________

Regan Visual Acuity ________ ________ ________

Bailey-Lovie High Contrast Sensitivity ____________

Appendix B

Informed Consent Sheet

RESEARCH PROJECT: IMPROVEMENT OF VISUAL PROCESSING

Participant Consent Form

I, ______________________________, voluntarily consent to participate in a research study on how the aging process affects vision. The study will take place in the Vision Laboratory at Western Kentucky University, Bowling Green, Kentucky and will involve no more than 10 one hour sessions. The nature and purpose of the study have been explained to me. I understand that I will be asked to view a video monitor and indicate when I see certain patterns on the screen. These sessions use standard eye exam and exercise procedures that involve no risk to the participant. In the event of eye or position fatigue, I know that I can take rest periods when I feel the need and can ask questions at any time.

I understand I will receive compensation for my participation. In addition to any improvements to my visual functioning I may also (participants over 60 years of age) receive a free ophthalmological exam.

All results and eye examinations will be treated as confidential information.

Any questions about the research may be directed to Dr. Karlene Ball (phone 745-4438).

I further understand that I may discontinue participation at any time.

______________________________ ______________________________

Date Signature

Funds for this research program are provided by the National Institutes of Health and Western Kentucky University.

Appendix C

Vision Questionnaires

To our patients:

On the next few pages you'll be asked to answer some questions about your driving experiences. The purpose of this survey is to gather information about the driving habits of adults, so that we can find solutions to any potential driving problems as they relate to vision. **Please be sure to answer each question**, taking as much time as you need.

All your answers are entirely confidential. In order for this survey to improve our knowledge about driving, **your answers must be as accurate and candid as possible**. Thank you ahead of time for your cooperation!

Before beginning, please fill in the blanks below.

Name ______________________________

Address______________________________

City ____________State ______ Zip-code _______

Phone number______________Birthdate__________

Today' Date ____________

Name of the Doctor you are seeing today ______________

Please turn the page and begin.

1. Have you ever had a driver's license

_____ yes _____ no

If you answered no, you are finished with this questionnaire; please return it to the receptionist.

2. At what age did you begin driving?

_____ years old

3. Do currently drive?

_____ yes _____ no

If no, why did you stop driving?

____

____

____

How old were you when you stopped driving? _____

If you have <u>not</u> been driving during the past five years, you are finished with this questionnaire; please return it to the receptionist.

In answering the rest of the questions, **please be sure to choose only one answer**. Choose the one that best applies to you and your situation.

4. About how many miles per year do you drive?

_____ under 1,000
_____ 1,000 to 5,000
_____ 5,000 to 10,000
_____ 10,000 to 20,000
_____ 20,000 to 30,000
_____ over 30,00

5. Do you make more than one trip in your car each day?

_____ yes _____ no

6. Below please circle the number of days per week you drive.

1 2 3 4 5 6 7

7. What is the longest trip, in terms of miles, you make in an average week? If you don't know the exact figure, please give us your best estimate.

_______ miles

8. Below please write in the make, model, and year of the car you drive most often.

Make___________________ Model_____________ Year_______

9. Does your car have an automatic transmission?

______ yes _____ no

10. Does your car have a tinted front windshield?

_____ yes _____ no

11. Do you wear your safety belt when you drive?

___never ___rarely ___sometimes ___often ___always

In answering the rest of the questions, please stop and take a minute to think about your driving experiences during the past ***five years.*** To help put yourself in this time frame, you may find it helpful to recall special events during the past five years, such as family birthdays, special holidays, and vacations, or personal losses.

Once again, we just want to emphasize that all your answers are entirely confidential.

12. Do you drive during the day?

___never ___rarely ___sometimes ___often ___always

13. Do you avoid driving at night?

___never ___rarely ___sometimes ___often ___always

14. Do you avoid driving on high-traffic roads, such as in the city?

___never ___rarely ___sometimes ___often ___always

15. Do you drive on low-traffic roads, such as on local neighborhood streets?

___never ___rarely ___sometimes ___often ___always

16. Do you drive in rush-hour traffic?

___never ___rarely ___sometimes ___often ___always

17. Do you avoid driving when it's raining?

___never ___rarely ___sometimes ___often ___always

18. Do you drive on interstate highways or expressways?

___never ___rarely ___sometimes ___often ___always

19. Do you avoid driving alone?

___never ___rarely ___sometimes ___often ___always

20. Do you drive while listening to the radio or car stereo?

___never ___rarely ___sometimes ___often ___always

21 Do you avoid parallel parking?

___never ___rarely ___sometimes ___often ___always

22. Do you avoid making left-hand turns across oncoming traffic?

___never ___rarely ___sometimes ___often ___always

Please turn the page and continue.

We are interested in learning about the number of car accidents you've had over the past ***five years***, when you've been the driver, regardless of whether anyone was injured, regardless of whether the accident was reported to the police, and regardless of whether the accident was your fault. In answering the questions below, if you cannot remember the exact number, please give us your best estimate.

23. Please circle the number of accidents (whether serious or minor) in which you've hit or bumped into something or someone over the past five years.

0 1 2 3 4 5 6 7 8 9 10 Over 10

24. How many of these accidents involved hitting or bumping a stationary object (like a pole, fence, trash can, parked car)?

0 1 2 3 4 5 6 7 8 9 10 Over 10

25. How many of these accidents involved hitting or bumping another vehicle?

0 1 2 3 4 5 6 7 8 9 10 Over 10

26. How many of these accidents involved hitting a pedestrian or a cyclist?

0 1 2 3 4 5 6 7 8 9 10 Over 10

27. Please circle the number of accidents in which another vehicle has hit or bumped you over the past five years.

0 1 2 3 4 5 6 7 8 9 10 Over 10

28. Please circle the number of accidents you've had over the past five years where the police were on the scene.

0 1 2 3 4 5 6 7 8 9 10 Over 10

29. Please circle the number of accidents you've had over the past five years which involved an injury to you or another person.

0 1 2 3 4 5 6 7 8 9 10 Over 10

30. Please circle the number of automobile insurance claims you have made over the past five years.

0 1 2 3 4 5 6 7 8 9 10 Over 10

31. Over the past five years have you ever had your insurance cancelled or been forced to seek an alternative insurance carrier due to a large increase in rates?

______ yes ______ no

32. How many times in the past five years have you been pulled over by the police, regardless of whether you received a ticket?

0 1 2 3 4 5 6 7 8 9 10 Over 10

33. How many times in the past five years have you received a traffic ticket (other than a parking ticket) where you were found to be guilty, regardless of whether or not you think you were at fault?

0 1 2 3 4 5 6 7 8 9 10 Over 10

34. Which way do you prefer to get around? Please choose only one.

______drive myself
______have someone drive me
______use public transportation

35. How fast do you usually drive compared to the general flow of traffic?

______Much faster
______Somewhat faster
______About the same
______Somewhat slower
______Much slower

36. Has anyone suggested over the past five years that you limit your driving?

______ yes ______ no

37. How would you rate the quality of your driving?

______Excellent
______Good
______Average
______Fair
______Poor

38. Please check the box below if you would like to learn more about our study on vision and driving. (We'll send you a brochure.)

Thank you for your cooperation. Please return the questionnaire to the receptionist.

Name ______________________________ **Birthdate** ____________

On the next few pages you'll read some statements about problems you may encounter during activities which involve your vision. Read each statement carefully. Then indicate how frequently you have the problem, by choosing the one word beneath the statement that best applies to you and your situation.

For example:

I have difficulty seeing when I'm outside at night.

never____ rarely____ sometimes____ often____ always____

First of all, we want you to answer all the questions **as if you were wearing your proper glasses or contact lenses (if any)**. Let's assume for the sake of this example that after reading this statement, you decide that you **sometimes** have difficulty seeing things when you're outside at night. Therefore, on the line beneath this statement, you would put an "X" next to the word **sometimes** to indicate that this is the word that best indicates how frequently you have this problem.

If you have any questions about how to do this survey, please ask the assistant now.

Please be sure to answer each question, taking as much time as you need. All you answers are entirely confidential. In order for this survey to improve our knowledge about vision problems and how they affect our daily activities, your answers must be as accurate and candid as possible.

Once again, if you wear glasses or contact lenses, please remember to answer all of the following questions as though you were wearing them.

1. How would you rate the quality of your vision?

____excellent
____good
____average
____fair
____poor

2. I find that visual information (for example, TV weather information and sports results) is presented too rapidly.

never____ rarely____ sometimes____ often____ always____

3. I have difficulty recognizing people or objects in dim light.

never____ rarely____ sometimes____ often____ always____

4. I find it difficult changing lanes in traffic because I have trouble seeing cars in the next lane.

never____ rarely____ sometimes____ often____ always____

5. I have trouble finding a specific item on a crowded supermarket shelf.

never____ rarely____ sometimes____ often____ always____

6. Reading street signs is difficult for me.

never____ rarely____ sometimes____ often____ always____

7. I have trouble on stairs because it's difficult for me to tell how high the steps are.

never____ rarely____ sometimes____ often____ always____

8. I have trouble following the ball in sports because it moves too fast and in unexpected directions.

never____ rarely____ sometimes____ often____ always____

9. I find it difficult to see curbs because they blend in with the street or sidewalk.

never____ rarely____ sometimes____ often____ always____

10. I have problems with lights around me causing glare when I'm trying to see something.

never____ rarely____ sometimes____ often____ always____

11. I have trouble locating a sign when it is surrounded by a lot of other signs.

never____ rarely____ sometimes____ often____ always____

12. I have problems reading small print (for example, phone book, newspapers).

never____ rarely____ sometimes____ often____ always____

13. When pouring liquid, I have trouble judging the level of the liquid in a container, such as the level of coffee in a cup.

never____ rarely____ sometimes____ often____ always____

14. I have trouble following TV programs in which scenes change rapidly.

never____ rarely____ sometimes____ often____ always____

15. I have trouble driving when there are headlights from oncoming cars in my field of view.

never____ rarely____ sometimes____ often____ always____

16. I have trouble reading the menu in a dimly lit restaurant.

never____ rarely____ sometimes____ often____ always____

17. When driving in traffic, I have trouble telling how far I am from the car in front of me.

never____ rarely____ sometimes____ often____ always____

18. Colors tend to look faded or washed out.

never____ rarely____ sometimes____ often____ always____

19. I have difficulty focusing on things at a distance after reading or doing close-up work.

never____ rarely____ sometimes____ often____ always____

20. I have trouble reading the credits (names of actors, etc.) at the end of a movie as they move up the screen, because they move too fast.

never____ rarely____ sometimes____ often____ always____

21. I have trouble seeing moving objects coming from the side until they are right in front of me.

never____ rarely____ sometimes____ often____ always____

22. I have trouble finding the person I'm looking for when he/she is in a group of people.

never____ rarely____ sometimes____ often____ always____

23. I avoid driving on unfamiliar roads.

never____ rarely____ sometimes____ often____ always____

24. I have difficulty reading small print under poor lighting.

never____ rarely____ sometimes____ often____ always____

25. I tend to confuse colors.

never____ rarely____ sometimes____ often____ always____

26. Merging into traffic is difficult because I have trouble getting a good view of cars approaching from behind.

never____ rarely____ sometimes____ often____ always____

27. I have difficulty doing any type of work which requires me to see well up close.

never____ rarely____ sometimes____ often____ always____

28. When driving at night in the rain, I have difficulty seeing the road because of headlights from oncoming cars.

never____ rarely____ sometimes____ often____ always____

29. I have trouble correctly judging the direction of a moving object.

never____ rarely____ sometimes____ often____ always____

30. Although I can recognize objects, they appear hazy and indistinct.

never____ rarely____ sometimes____ often____ always____

31. When somebody shows me something, I don't have enough time to see it properly.

never____ rarely____ sometimes____ often____ always____

32. I have problems seeing other cars and obstacles on the road when I'm driving after dark.

never____ rarely____ sometimes____ often____ always____

33. I have a hard time following a moving object with my eyes.

never____ rarely____ sometimes____ often____ always____

34. I have problems with blurry vision or eyestrain.

never____ rarely____ sometimes____ often____ always____

35. I have problems adjusting to bright room lighting, after the room lighting has been rather dim.

never____ rarely____ sometimes____ often____ always____

36. The steering wheel or dashboard gets in the way of my seeing a full view of the road.

never____ rarely____ sometimes____ often____ always____

37. I have problems locating something when it's surrounded by a lot of other things.

never____ rarely____ sometimes____ often____ always____

38. The numbers on rulers and tape measures are hard for me to read.

never____ rarely____ sometimes____ often____ always____

39. The color names that I use disagree with those that other people use.

never____ rarely____ sometimes____ often____ always____

40. I have trouble reading a sign or recognizing a picture when it's moving, such as an ad on a passing bus or truck.

never____ rarely____ sometimes____ often____ always____

41. When I'm walking along, I have trouble noticing objects off to the side.

never____ rarely____ sometimes____ often____ always____

42. I have trouble reading the price tags on supermarket shelves or on the item itself.

never____ rarely____ sometimes____ often____ always____

43. It takes me a long time to adjust to darkness after being in bright light.

never____ rarely____ sometimes____ often____ always____

44. In unfamiliar places, I am more likely to bump into things.

never____ rarely____ sometimes____ often____ always____

45. It takes me a long time to find an item in an unfamiliar store.

never____ rarely____ sometimes____ often____ always____

46. Sometimes when I reach for an object, I find that it is further away (or closer) than I thought.

never____ rarely____ sometimes____ often____ always____

47. Reading the dials and directions on appliances (for example, washing machine, stove) is especially difficult for me when the room is not well lit.

never____ rarely____ sometimes____ often____ always____

48. I have problems judging how close or far things are from me.

never____ rarely____ sometimes____ often____ always____

49. I have difficulty reading traffic signs or signals soon enough to react.

never____ rarely____ sometimes____ often____ always____

50. I have trouble watching TV when lights from another part of the room are reflected onto the TV screen.

never____ rarely____ sometimes____ often____ always____

51. When I'm driving, other cars surprise me from the side, because I don't notice them until the last moment.

never____ rarely____ sometimes____ often____ always____

52. I bump my head (for example, going down stairs, getting in car) because I misjudge the distance of objects.

never____ rarely____ sometimes____ often____ always____

53. Regarding traffic signals, I rely more on the brightness and the position of the light rather than on its color.

never____ rarely____ sometimes____ often____ always____

54. I have trouble reading the instrument panel on my car when driving at night.

never____ rarely____ sometimes____ often____ always____

55. I have trouble telling the difference between dark colors, such as when sorting dark socks.

never____ rarely____ sometimes____ often____ always____

56. When I'm driving, my car seems to be going faster than the speedometer indicates.

never____ rarely____ sometimes____ often____ always____

57. I often wish that a lamp I'm using had a brighter setting or brighter light bulb.

never____ rarely____ sometimes____ often____ always____

58. I have difficulty reading the instrument controls on my car's dashboard.

never____ rarely____ sometimes____ often____ always____

59. It takes me a long time to adjust to bright sunshine after I have been inside a building for a lengthy period of time.

never____ rarely____ sometimes____ often____ always____

60. When driving at night, objects from the side unexpectedly appear or pop up in my field of view.

never____ rarely____ sometimes____ often____ always____

61. I have difficulty distinguishing between colors.

never____ rarely____ sometimes____ often____ always____

62. I have problems carrying out activities that require a lot of visual concentration and attention.

never____ rarely____ sometimes____ often____ always____

63. I have trouble finding things I'm looking for in a dimly lit room.

never____ rarely____ sometimes____ often____ always____

64. I have difficulty noticing when the car in front of me is speeding up or slowing down.

never____ rarely____ sometimes____ often____ always____

65. I have problems seeing steps at night or when poorly illuminated.

never____ rarely____ sometimes____ often____ always____

66. I bump into people in a busy store because I have problems seeing them in my peripheral vision.

never____ rarely____ sometimes____ often____ always____

67. I have trouble adjusting from bright to dim lighting, such as when going from daylight into a dark movie theater.

never____ rarely____ sometimes____ often____ always____

68. Other cars on the road seem to be going too fast.

never____ rarely____ sometimes____ often____ always____

69. When pouring liquid, I have trouble judging the correct location of the glass or cup.

never____ rarely____ sometimes____ often____ always____

70. I have difficulty seeing things clearly in the distance.

never____ rarely____ sometimes____ often____ always____

71. I have trouble noticing things in my peripheral vision.

never____ rarely____ sometimes____ often____ always____

72. Bright sunshine on a dirty windshield interferes with my driving.

never____ rarely____ sometimes____ often____ always____

73. Other people seem to switch TV channels too fast for me.

never____ rarely____ sometimes____ often____ always____

74. During night driving, headlights reflected in my rear-view mirror make it difficult to see.

never____ rarely____ sometimes____ often____ always____

75. I have problems bumping into things in unfamiliar places with poor lighting.

never____ rarely____ sometimes____ often____ always____

76. It seems like I have to look at things for a long time before I can recognize them.

never____ rarely____ sometimes____ often____ always____

77. I have trouble reading the labels on my medicine bottles and containers.

never____ rarely____ sometimes____ often____ always____

78. I have trouble staying in the center of my driving lane.

never____ rarely____ sometimes____ often____ always____

79. Things look more yellowish than they used to.

never____ rarely____ sometimes____ often____ always____

80. I have trouble parking my car because it is difficult for me to judge distances.

never____ rarely____ sometimes____ often____ always____

81. I find that when riding in a fast car or train, the visual scene moves by so quickly that I have trouble making anything out.

never____ rarely____ sometimes____ often____ always____

82. It takes me a long time to get acquainted with new surroundings.

never____ rarely____ sometimes____ often____ always____

83. It takes me more time to read things than it really should.

never____ rarely____ sometimes____ often____ always____

84. I am extra careful when I cross streets because cars seem to appear from nowhere.

never____ rarely____ sometimes____ often____ always____

85. Reading street signs is especially difficult for me when it gets dark.

never____ rarely____ sometimes____ often____ always____

86. If you had to list three common problems you have in your visual activities, what would they be?

1. ______________________________

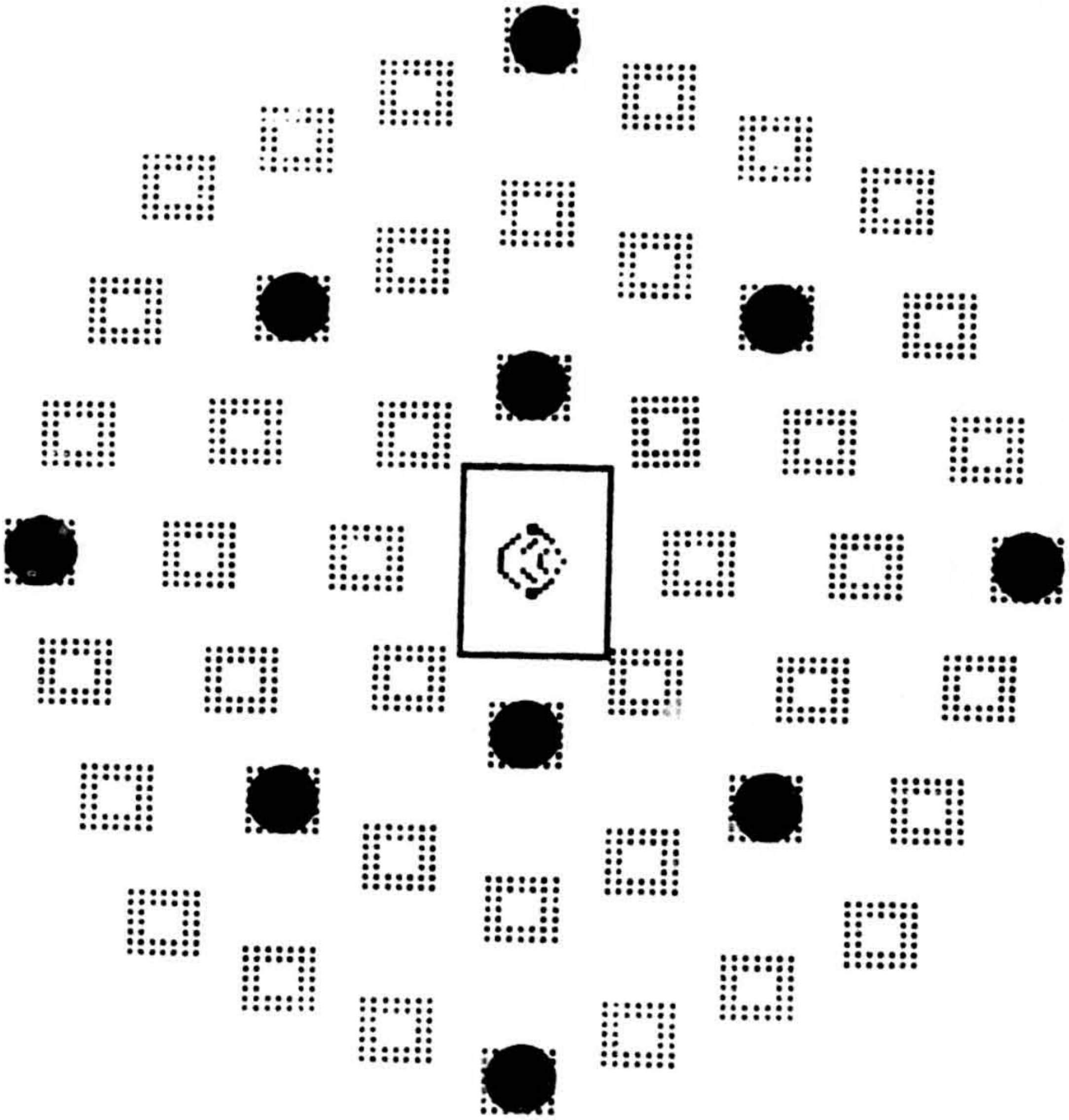
2. ______________________________

3. ______________________________

<u>Thank you</u> for your cooperation. Please return the questionnaire to the assistant.

Appendix D

Organized Pattern



Appendix E

Unorganized Pattern