Journal of Applied Psychology
1968, Vol. 52, No. 1, 10–15

LATERAL VISUAL FIELD AS RELATED TO AGE AND SEX [1]

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Lateral nasal and temporal visual field measurements were obtained by means of a screening perimeter for nearly 17300 Ss, ages 16–92. The major findings are: (a) temporal and total fields are maximum to about age 35, after which field constricts progressively with advancing age, (b) nasal fields increase to a maximum occurring about age 35 or 40, after which a progressive decline takes place, and (c) females consistently demonstrate slightly larger visual fields than men. Possible interpretations for these and other findings are presented, and additional research is suggested to explain some of the relationships obtained in the study.

From 1961 through 1966, the author directed a large-scale research project investigating the relationships between vision and driving. The major conclusions from this study are presented in a recent report (Burg, 1967b).

Apart from data relating vision to driving, the study produced a very great amount of information concerning visual performance as a function of age, sex, and other variables. The present paper is one of a series of reports (including Burg, 1966 and 1967a) presenting normative data on vision that should be of interest to others working in this area.

METHOD

Apparatus

The device used for testing lateral visual field was an American Optical Company screening perimeter, fixed in a horizontal position (Figure 1). The perimeter has a 30-cm.-radius black mat arc, with recessed 4-mm. white targets located at 5° intervals around the arc. Each of the targets is activated by depressing a spring-loaded plunger on the back side of the arc, and the target disappears from view as soon as the plunger is released. Each target subtends approximately 46 min. of arc. At each end of the arc is a sighting device for obtaining the correct eye level and 30 cm. distance from the cornea to the fixation point (a 4-mm. white target in the center of the arc). An adjustable double chin rest is used to obtain this proper positioning of *S*'s head for monocular testing. The arc is evenly illuminated by a 50-w., 120-v. incandescent bulb mounted above *S*'s head on the axis of curvature of the arc.[2] The targets are approximately 69 cm. from the center of the light source. A black cloth is suspended from the lower edge of the arc to screen out *E*'s arm movements when he is manipulating the target plungers.

Three testing units were in simultaneous operation during the course of the data-collection phase of

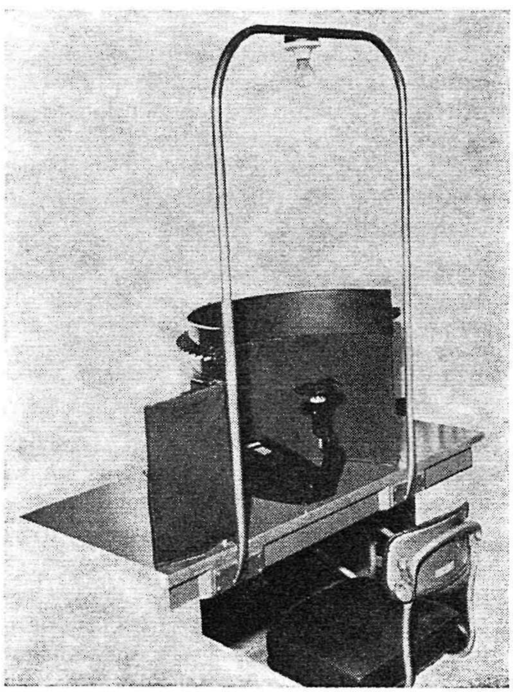

FIG. 1. Lateral visual field screening apparatus.

[1] Data collection and analysis costs were partially borne by the United States Public Health Service (Grant AC-00015), and the State of California and United States Bureau of Public Roads (California Standard Agreement 13600).

[2] Target illumination is 7.5 ftc. measured perpendicular to the light source-to-target axis. When measured perpendicular to the subject-to-target line of sight, target illumination is approximately 2 ftc.

the study. To insure comparable scores, the perimeter test setup was identical in every respect in all situations. All testing was conducted in light-free rooms, with the perimeter arc solely illuminated by the aforementioned 50-w. bulb. (Needless to say, the several test operators employed during the 32-mo data-collection period were all highly trained to administer the test in an identical manner)

Procedure

After *S* was seated at the perimeter (on an adjustable-height chair), he rested his chin on the right side of the chin rest (covered by a tissue), placing his left eye in line with the fixation target in the center of the arc. Using the sighting devices at each end of the arc, *E* adjusted the chin rest and the tilt of *S*'s head until the latter's eye was at the proper level and distance from the fixation target

The *S* then was asked to hold a folded tissue over his right eye. Care was taken that the left-eye nasal field was not intruded upon, either by the tissue or by *S*'s hand. Standing behind the perimeter, *E* asked *S* to fixate with his left eye upon the fixation target (*E* monitored *S*'s adherence to this instruction throughout the test). Using a modified method of limits, *E* then established the (lateral) nasal and temporal limits of *S*'s left-eye field, by recording the position of the furthest target perceived by *S*, both nasally and temporally. If it appeared necessary, measurements were repeated to insure that *S*'s responses were accurate and that his eyeglass frames, if any, were not obscuring the targets.[3] The *S* then placed his chin in the left side of the chin rest, and his right-eye nasal and temporal fields were similarly measured

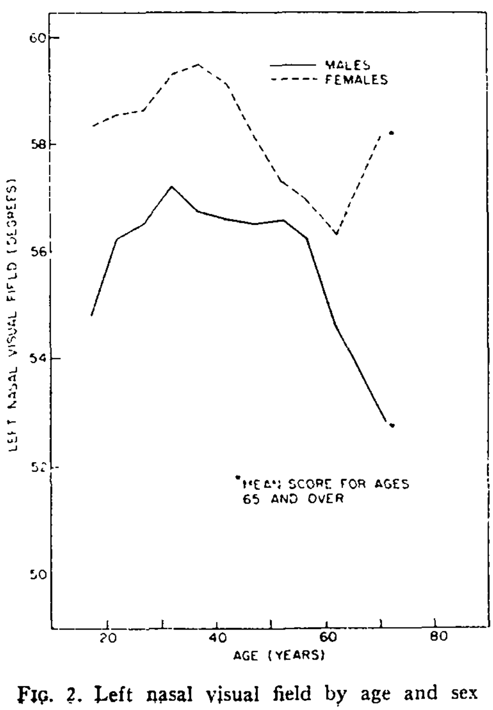

FIG. 2. Left nasal visual field by age and sex

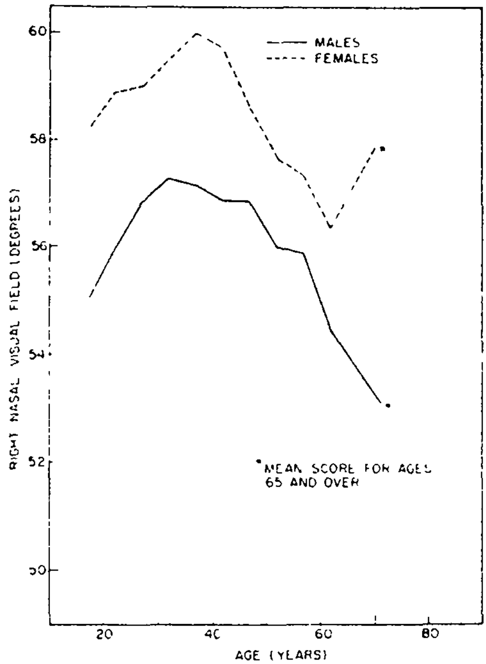

FIG 3 Right nasal visual field by age and sex

Subjects

The *Ss* were California drivers who were voluntarily participating in the vision and driving study mentioned earlier A total of 17,479 *Ss* were involved in the program, 62.8% of whom were male and 37.2% female. The age range was from 16 to 92, and (corrected) static acuity ranged from 20/13 to 20/200. The *Ss* were tested at branch offices of the California Department of Motor Vehicles scattered throughout the State

RESULTS

Table 1 presents a summary, by age and sex, of mean monocular nasal and temporal fields, as well as total monocular and binocular fields Figures 2 through 8 present graphical depictions of these data.

The tabular and graphical data are based on somewhat less than 17,300 *Ss*; approximately 200 *Ss* were not included in the present analyses, either because they did not have

[3] The *Ss* were tested with corrected vision, if they indicated that they wore corrective lenses *to drive*,

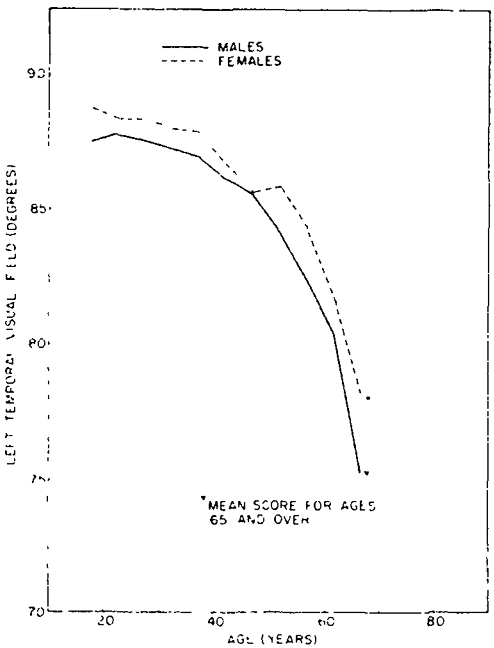

FIG. 4 Left temporal visual field by age and sex

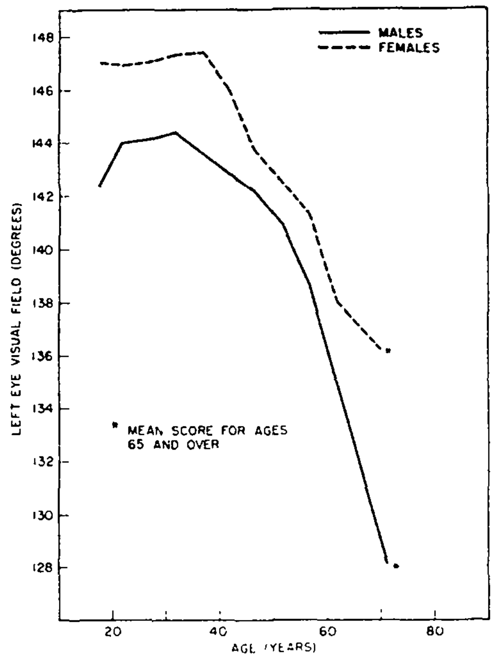

FIG. 6. Left-eye visual field by age and sex.

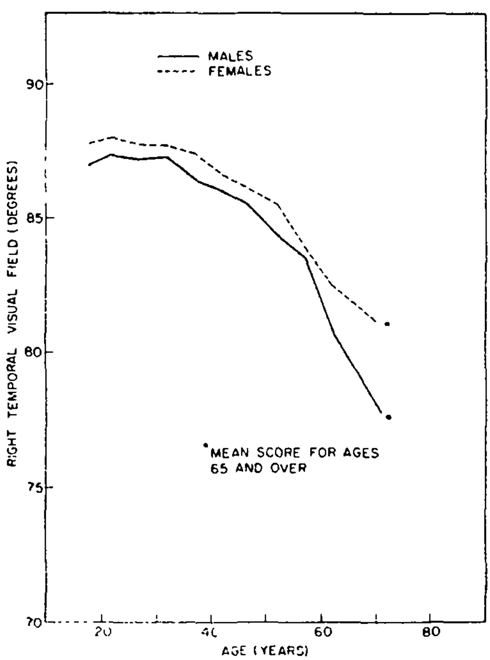

FIG 5. Right temporal visual field by age and sex.

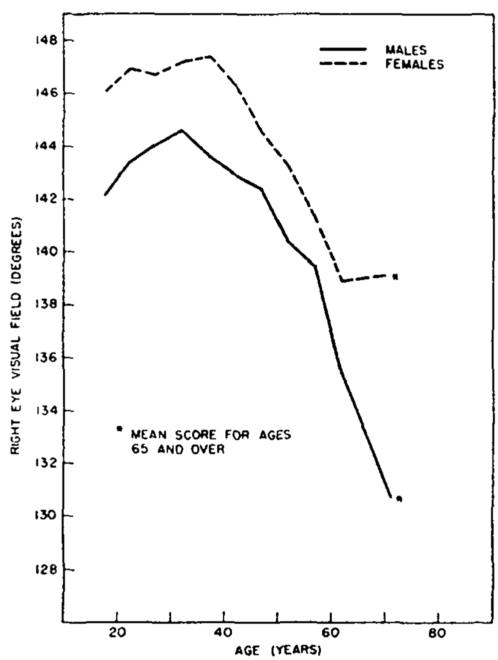

FIG 7. Right-eye visual field by age and sex

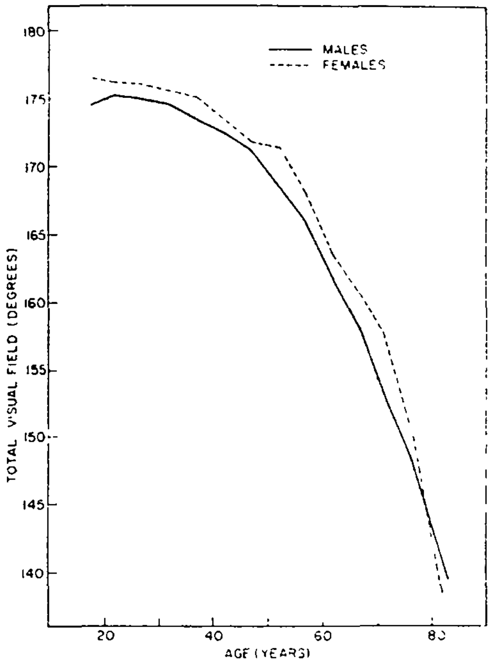

FIG. 8 Total visual field by age and sex.

valid perimeter scores (e.g., they failed to maintain steady fixation upon the central target), or because they were blind in one eye. (Because of their special nature, one-eyed *S*s are being analyzed separately, and will be the subject of a future report.)

Inconsistencies among the cell sample sizes evident in Table 1 are due to the fact that different computer runs provided data for different sections of the table, and a few *S*s had invalid scores for some, but not all, of the variables under consideration.

Upon inspection of the above table and graphs, the following general statements may be made:

1. Field versus Age:

(*a*) For both sexes, total visual field and both temporal fields are at their maximums from age 16 up to about age 35, after which point field decreases progressively with advancing age.

(*b*) For both sexes, nasal fields and (therefore) eye fields increase up to a maximum

TABLE 1

SUMMARY OF MEAN VISUAL FIELD SCORES BY AGE AND SEX

Age	Sex	Left nasal field (in degrees)		Right nasal field (in degrees)		Left temporal field (in degrees)		Right temporal field (in degrees)		Left-eye visual field (in degrees)		Right-eye visual field (in degrees)		Total visual field (in degrees)		
		N	$\bar{X}$	N	$\bar{X}$	N	$\bar{X}$	N	$\bar{X}$	N	$\bar{X}$	N	$\bar{X}$	N	$\bar{X}$	SD
16–19	M	1181	54 9	1181	55 1	1181	87 5	1181	87 0	1181	142 4	1181	142 1	1182	174 5	9 1
	F	732	58 3	732	58 3	732	88 7	732	87 8	732	147 0	732	146 1	732	176 4	5 5
20–24	M	1380	56 2	1381	56 0	1380	87 8	1381	87 3	1380	144 0	1381	143 3	1379	175 2	7 7
	F	775	58 5	776	58 9	775	88 4	776	88 0	775	146 9	776	146 9	776	176 1	8 8
25–29	M	1159	56 5	1159	56 8	1159	87 6	1159	87 2	1159	144 1	1159	144 0	1158	174 9	7 5
	F	664	58 7	664	59.0	664	88 3	664	87 7	661	147 0	664	146 7	665	176 0	9 0
30–34	M	1118	57 2	1117	57 3	1118	87 2	1117	87 3	1118	144 4	1117	144 6	1116	174 6	7 7
	F	629	59 3	629	59 5	629	88 0	629	87 7	629	147 3	629	147 2	631	175 6	7 2
35–39	M	1118	56 7	1114	57 2	1118	86 9	1114	86 4	1118	143 6	1114	143 6	1114	173 4	9 8
	F	691	59 5	692	60 0	691	87 9	692	87 4	691	147 4	692	147 4	690	175 1	6 7
40–44	M	1121	56 6	1120	56.9	1121	86 2	1120	86 0	1121	142.8	1120	142 9	1119	172 5	9 2
	F	718	59 2	717	59.7	718	86 7	717	86 6	718	145 9	717	146 3	717	173 5	7 6
45–49	M	937	56 5	937	56 9	937	85 6	937	85 5	937	142 1	937	142 4	935	171 2	8 6
	F	640	58 1	640	58.6	640	85 6	640	86 0	640	143 7	640	144 6	640	171 8	10 0
50–54	M	852	56 6	852	56.0	852	84 2	852	84.3	852	140 8	852	140 3	849	168 4	11 5
	F	577	57.3	576	57 7	577	85.9	576	85 5	577	143 2	576	143 2	576	171 5	9 7
55–59	M	633	56 2	629	55.9	633	82 4	629	83 5	633	138.6	629	139 4	629	165 9	13 4
	F	374	57 0	375	57 4	374	84 3	375	83 9	374	141 3	375	141 3	374	168 0	10 3
60–64	M	488	54 6	488	54.5	488	80 4	488	80 9	488	135.0	488	135 4	487	161.5	16 9
	F	265	56 3	265	56 4	265	81 7	265	82 5	265	138 0	265	138 9	265	163 7	14 4
65–69[a]	M	883	52 8	883	53 1	883	75 3	883	77 6	883	128 1	883	130.7	401	158 0	16 5
	F	350	58 1	350	57 9	350	78 1	350	81 2	350	136.2	350	139 1	205	160 6	12 5
70–74	M													266	152.8	16 3
	F													95	157 6	13 8
75–79	M													136	147 7	21 2
	F													36	150 0	20 1
80 + over	M													76	139 5	21 4
	F													13	138 5	21 5
All	M	10870	55 6	10861	55 7	10870	85 3	10861	85 2	10870	140 9	10861	140 9	10849	170 8	12 4
	F	6415	57.8	6416	58 1	6415	86 6	6416	86 2	6415	144 4	6416	144 3	6409	172.9	10 3
All	Both	17285	56 4	17277	56 6	17285	85 8	17277	85 6	17285	142 2	17277	142.2	17249	171 6	11 7

[a] Values given are for ages 65 and over for all measures except *total* visual field

occurring about age 35–40, followed thereafter by progressive decreases with increasing age, with the exception of an increase for females age 65 and over.

(*c*) For both sexes, right-temporal and right-eye visual fields are smaller than their left counterparts for the younger age groups, while the reverse is true for the older age groups. This effect is not exhibited for the nasal fields.

2. Field versus Sex:

(*a*) With the exception of the (relatively small) over-80 age group, females consistently demonstrate larger nasal and temporal visual fields (and, consequently, larger eye fields and total fields) than do men. The greatest difference is evident in the nasal fields.

(*b*) For both nasal and eye fields, females achieve their maximum values between the ages of 35 and 40, while for males this maximum occurs between ages 30 and 35.

An additional finding is that the product-moment correlation between total visual field and age is slightly but significantly less for females (−.420) than it is for males (−.462).

Discussion[4]

Field versus Age

The results of the present study, showing a progressive decline in visual field with increasing age, are consistent with most previous research studies of a similar nature. However, the *interpretations* of findings of this type have *not* been consistent. As Weale (1963) points out, one reason for this lack of consistency is the fact that senile degeneration of the visual mechanism takes several forms, some of which may intrude upon visual-field measurements and consequently lead to mistaken conclusions as to causal relationships. For example, the assumption usually made states that visual field constricts with age due to peripheral degeneration of the retina. However, it is well known that sensitivity to light diminishes with increasing age, possibly due to the gradual yellowing of the crystalline lens and/or because of reduction in pupil diameter (senile miosis), and that visual sensitivity decreases as the peripheral retina is approached. As a consequence, visual-field measurements using perimeters whose arcs are evenly illuminated at a fixed intensity, Weale continues, may show decreasing field with increasing age because of decreased light sensitivity and *not* necessarily because of a true peripheral degeneration of the retina. Weale concludes that if stimulus intensity were increased to compensate for these effects, restrictions in visual field would be shown to be caused primarily by physical changes in the ocular system, rather than by retinal decay.

Regardless of the validity of Weale's viewpoint, from a practical standpoint the problem he raises is not particularly germane to the present study. The research herein described is concerned with investigating the functional limits of visual field by means of a measurement technique that is of sufficient accuracy *and* ease of administration to permit its use as a high-volume testing device (e.g., for driver-license applicants). Thus, the emphasis is on rapid visual *screening* rather than on detailed clinical evaluation. Practically speaking, if measurement conditions are identical for all *S*s, the fact that visual field constricts with increasing age is of importance *regardless* of the physiological reasons underlying this change. In the performance of a task such as driving, in which visual-field restrictions *do* appear to act as a handicap (Burg, 1967b), establishing the fact of these restrictions is a proper and important function of the licensing agency, while etiological diagnosis and possible remedial measures (if any) are the responsibility of the clinician.

One additional point needs clarification. The visual-field values derived in the present study are of importance primarily as indications of *relative* size as a function of age and sex. It is not intended that the obtained mean scores be considered completely accurate in any absolute sense, for at least two reasons:

1. The screening test used provides scores that may underestimate the true values, because the targets are spaced at 5° intervals. From a statistical standpoint, a closer approximation of the true field values could be

[4] The assistance of Frank A. Brazelton (Optometry) and Glenn O. Dayton (Ophthalmology) in interpretation of the study findings is gratefully acknowledged.

obtained by adding 2.5° to each mean nasal- or temporal-field score, and 5.0° to each mean eye-field or total-field score.

2. The target illumination used was somewhat lower than is commonly found in perimetric investigations and, therefore, may possibly have slightly penalized the older *S* because of the light-sensitivity decline mentioned earlier. If such a penalty was in fact imposed, however, in all likelihood its magnitude was minor, because of the substantial size and reflectance of the white perimeter targets used.

In contrast to the temporal fields, the nasal fields initially increase in size before commencing their progressive decline with age. There is no obvious explanation for this finding; conceivably, it may be due to a physiognomic change in eye-nose relationships occurring up to ages 35–40. If such is the case, this change reverses direction in the older age groups, where gradual recession of the eye (relative enophthalmos) causes the nose increasingly to intrude upon the nasal field (Weale, 1963). Both nasal and temporal fields show marked declines after ages 35–40; if anything, however, the temporal fields exhibit a greater decline (both absolute and relative) than do the nasal fields.

Similarly, at present no readily acceptable explanation can be offered for the reversal in relative size that seems to occur, with age, between the right temporal and monocular fields, and the corresponding fields for the left eye. As yet unpublished monocular visual acuity data for these *S*s do not exhibit corresponding changes with age. As is possible with *any* research study, this finding (as well as other results) may be the consequence of an artifact in the data; however, in view of the large sample size and the extreme care taken to maintain standardized experimental conditions, the likelihood of experimental artifact providing a reasonable explanation for this outcome appears quite small.

Field versus Sex

No obvious explanations can be offered either for the slight but significant superiority in visual-field size demonstrated by females or for the fact that nasal and (consequently) eye fields peak at a later age for females than for males. The fact that visual field correlates with age slightly less for females than for males *can* be explained, however, by the smaller sample size for females, which results in a narrower range of scores (see the standard deviations presented in Table 1) and, consequently, a statistical limitation on the size of the correlation obtainable.

In summary, it may be said that several of the study findings pose interesting questions of interpretation. Additional research obviously is necessary if reasonable answers to these questions are to be found. For example, it would be desirable to obtain field measurements on a large number of *S*s with higher levels of target illumination, physiognomic evaluation, pupil-size measurements, and so on. Data collected in the present study are currently being subjected to more detailed analysis to determine whether, despite the precautions taken, those *S*s who were tested wearing glasses (some 32% of the total) were in fact experiencing restrictions in their field while being measured that could in some way account for some of the findings. Other analyses in the planning stages include the effects of smoking and fatigue (lack of sleep) upon visual performance; however the likelihood is small that either of these analyses will provide satisfactory explanations for any of the findings described above.

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(Early publication received August 21, 1967)