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**THE RELATION TO ACCIDENT OF PHYSICAL DEFECTS NOTED IN
STANDARD G. A. A. MEDICAL EXAMINATIONS**

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The literature of aviation medicine abounds in references to a reputed relation between detected physical defects and accident. The evidence of relationship is, of course, confined to defects which are not serious enough to ground the pilot since no accident could otherwise occur subsequent to the examination.

Special reference should be made to an article by L. H. Bauer, entitled "Aeronautics and the Practice of Medicine" in the Journal of Aviation Medicine, June 1930. In this article and others quoting the same sources, the claim is made that the accident rate in normal pilots is very much lower than is that of pilots with physical defects. * H. J. Cooper, in articles appearing in the Journal of Aviation Medicine and elsewhere makes these same claims in 1930 and 1931. The sources of the evidence and the methods of calculation are not presented.

Other statistical material has never confirmed these claims. An article by G. I. Jones in the Military Surgeon, 1932, for instance, indicates that of 1478 pilots flying without a waiver, 147, or a little less than 10 percent crashed, whereas of 193 flying with a waiver only 11, or less than 6 percent crashed. Dean R. Brimhall in an unpublished

*See Air Commerce Bulletin Vol. 3, No. 5, September 1, 1931.

paper showed that there were not enough fatalities in the civilian pilot materials which Bauer and Cooper claim to have analyzed, to justify their assertions in regard to them.

All of this confusion, however, has surprisingly resulted in a general acceptance of the claims which are quoted throughout the literature. It seemed essential to us to investigate these claims and at least decide whether the evidence available is sufficient to allow a statistical calculation. There was, and is, considerable doubt on this point because the consistency of medical notation is so low that pilots appear in the records as having and not having defects in bewildering succession.* This inconsistency would, of course, tend to lower any relationship between a noted defect and an accident in a subsequent period. It also made the task of analysis much more difficult than it otherwise would have been because it was necessary to associate a pilot having a defect with a period during which this reputed defect might possibly affect his flying. It must be emphasized that we are discussing defects not serious enough to disqualify the pilot. It should be no mystery why medical diagnosis in this range is unreliable and unobjective.

In order to study the question it was decided to make the following segregation of material for each defect in each of fifteen four-month periods, - January 1935 to December 1939, inclusive:

1. Cases having an accident within a period and a particular defect noted on the most recent medical examination preceding that accident.

* "Problems of Consistency Arising from CAA Medical Examinations"
by Raymond Franzen and Dean R. Brimhall, Civil Aeronautics
Administration publication, February 17, 1942.

2. Cases having an accident during that same period but having no defect of that particular type noted by the most recent medical examination which must have occurred during the period or during one year previous to the beginning of the period.
3. Cases having the particular defect noted in a medical examination made within this same period, or within a year previous to that period but not having an accident during that period.
4. By subtraction all other pilots eligible to fly during that period.

The defects for which this type of statistical material was developed are as follows:

Visual acuity	Hearing
Depth perception	Structural
Eye muscle balance	Cardio-vascular
Central color vision	Psychiatric

It was, of course, advisable to make as many divisions by class of pilot as were possible. Because the classification materials were not entirely adequate, a few "amateur" pilots, not solo, were combined with "private license". The other classifications are solo, limited commercial, and commercial. The solo classification is made up of solo licenses granted during 1938 and 1939. It includes only pilots who have not yet had sufficient flying experience to be granted a private license. They are in a true sense beginners.

The method of classification involves multiple use of individuals. A pilot may, of course, appear in the same or in a different category at different periods. This is true of his classification as accident or non-accident, defect of a given type, or clear of that defect, and in respect to his flying class. He can, of course, appear only once in each defect study for each period. The unit which we are studying is a pilot eligible to fly in a particular four-month period. This unit is

studied in respect to the relationship between defect and accident. One important reason for the choice of this unit was to avoid the serious problem of variation in exposure to accident involved in longer time spans.

Since the number of cases is small, except for vision defect, we first tabled a combination of these units for the five-year period. The subject matter is four-month flying experiences 1936 to 1939 inclusive. Table 1 shows the relation between accident and defect, for accidents which occurred during the solo stage in 1938 and 1939 the two years in which solo licenses were granted.

T A B L E 1

THE RELATION OF DEFECTS TO ACCIDENTS COMBINING SIX PERIODS

COVERING 1938-1939 INCLUSIVE
(Solo)*

Type of Defect	No. of De- fects	No. of Acci- dents	Chance No. of Acci- dents with Defect	Actual No. of Acci- dents with Defect	Direction ‡ is more actual, - is more chance	Probability of such a distri- bution by chance (out of 100)
Vision	3148	358	55.9	72	‡	2
Color Vision	120	358	2.1	5	‡	4
Hearing	82	358	1.5	4	‡	4
Structural	80	358	1.4	4	‡	3
Cardio-vascular	57	358		1		
Psychiatric	4	358		0		

* Only two years of this classification available.

The table is read in the following manner: There were 3148 four-month flying experiences in which the pilot had a visual defect on his record during the period of eligibility counted (visual defect includes visual acuity, corrected or not, muscle imbalance or depth perception.) During these 3148 man-flying periods there were 358 accidents. It may be noted that the same individual might have been involved in more than one of these accidents, but that seven-eighths of the accidents are one to each pilot. Two accidents within a period are extremely rare and were not counted double.* Since the total eligibility during these periods is known we are able to determine the number of accidents by pilots with this defect, which would occur by chance alone.

If there were no relationship whatever between visual defect and accident there would have been 55.9 accidents by pilots having a visual defect. Actually there were 72. The plus in the next column indicates that there were actually more accidents than chance, and the 2 in the final column indicates that an arrangement such as this could happen by chance only two times out of a hundred. The computation is

* The distribution of pilots in terms of number of accidents is as follows:

<u>Number of Accidents</u>	<u>No. of Pilots having one or more accidents</u>
1	7031
2	687
3	207
4	42
5	14
6	11
7	1
8	2
Total	7995

chi-squared. The total data involved are as follows:

	<u>Accident</u>	<u>No accident</u>	<u>Total</u>
Defect	72	3076	3148
No defect	286	16716	17002
Total	358	19792	20150

Total accidents = 358

Total defects = 3148

Chance accident-defects = $358 \times \frac{3148}{20150} = 55.9$

Actual minus theoretical = $72 - 55.9 = 16.1$

Chi-squared = 5.6

Chi = 2.37 and with one degree of freedom a chi of this size occurs only twice out of a hundred in chance arrangements.

There are four cells in this distribution. Three of these are direct counts and cannot be in error though they did necessitate multiple placement of individuals. The fourth cell is obtained by subtraction from total eligibility to fly. If estimates of total eligibility are too high, then the positive relation will be spuriously increased and if they are too low, then the negative relation will be spuriously increased. Our estimates of private flying may be a little too low but the other estimates are accurate.

It is clear from Table 1 that wherever there were enough noted defects to make the calculation reasonable, the relation is positive. The probabilities of attaining the relations pictured by chance are 2, 4, 4, and 3 out of a hundred in vision, color vision, hearing, and structural defect respectively.

T A B L E 2

THE RELATION OF DEFECT TO ACCIDENTS COMBINING FIFTEEN

PERIODS COVERING 1935-1939 INCLUSIVE

(Commercial Pilots)

Type of Defect	No. De- fects	No. of Acci- dents	Chance No. of Acci- dents with Defect	Actual No. of Acci- dents with Defect	Direction † is more actual, - is more chance	Probability of such a distri- bution by chanc (out of 100)
Vision	8191	3081	239.4	204	-	1
Color Vision	945	3081	27.6	27	-	90
Hearing *	818	2916 *	24.3	13	-	2
Structural	1353	3081	39.5	39	-	94
Cardio-vascular	386	3081	11.3	9	-	48
Psychiatric	37	3081		0		

Table 2 presents similar evidence for commercial pilots. All of these relations are negative but only two of them are reliable. In the case of vision and hearing the chances of having as few accidents by pilots having a defect as we actually do are only 1 and 2 out of a hundred respectively. This certainly does not substantiate the hypothesis generally held to be true that accident rate is higher for pilots with a defect than it is for others.

We may definitely state that if there is any relation at all it is compensatory, that is, pilots in the commercial class with visual or hearing defect are less likely to have an accident than are those free

* First period in 1935 excluded from this calculation.

from the defect. The difference in respect to the other defects is so small as to be negligible. Commercial pilots with visual and hearing defects are less likely to have accidents than others and commercial pilots having other defects are equally, but certainly not more likely, to have accidents than are normal pilots in this class.

T A B L E 3

THE RELATION OF DEFECTS TO ACCIDENTS COMBINING FIFTEEN

PERIODS COVERING 1935-1939 INCLUSIVE

(Private Pilots)

Type of Defect	No. of Defects	No. of Accidents	Chance No. of Accidents with Defect	Actual No. of Accidents with Defect	Direction † is more actual, - is more chance	Probability of such a distribution by chance (out of 100)
Vision	26201	2653	582.1	618	†	9
Color Vision	1289	2653	28.6	31	†	65
Hearing	1110	2653	24.7	26	†	79
Structural	1248	2653	27.7	30	†	66
Cardio-Vascular	452	2653	10.0	5	-	11
Psychiatric	77	2653	1.7	3	†	31

T A B L E 4

THE RELATION OF DEFECTS TO ACCIDENTS COMBINING FIFTEEN

PERIODS COVERING 1935-1939 INCLUSIVE

(Limited Commercial)

Type of Defect	No. of De- fects	No. of Acci- dents	Chance No. of Acci- dents with Defect	Actual No. of Acci- dents with Defect	Direction ‡ is more actual, - is more chance	Probability of such a distri- bution by chance (out of 100)
Vision	1017	433	31.6	35	‡	52
Color Vision	184	433	5.7	8	‡	32
Hearing	90	433	2.8	3	‡	90
Structural	154	433	4.8	2	-	19
Cardio-vascular	49	433	1.5	0	-	21

Tables 3 and 4 portray the same types of material for private pilots and limited commercial respectively. The figures in the last column indicate that the differences which occur are so small that they may easily have occurred by chance. It is true that in the case of private pilots there are more accidents with pilots having a visual defect than there would be by chance alone, but the difference is so small that it would have occurred nine times out of a hundred by chance. It becomes necessary to analyze these materials in more detail. If, for instance, the relation should be positive for each period, then even though the possibility of such differences occurring by chance is large, the consistency of the relationship would still make it significant.

Table 5 presents this more analytic statement for visual acuity alone and Table 6 presents the same type of analysis for visual defect of all types. In Table 6 a particular unit, consisting of a pilot flying in a given four-month period was counted only once, no matter how many of the visual defects he possessed.

T A B L E 5

THE RELATION OF VISION DEFECT, (ACUITY, CORRECTED OR NOT)

TO ACCIDENTS

(Private Pilots)

Period Year-Thirds	No. of De- fects	No. of Acci- dents	Chance No. of acci- dents with defect	Actual No. of Acci- dents with defect	Direction † is more actual, - is more chance	Probability of such a distri- bution by chance (out of 100)
1935 - 1	1026	90	17.3	22	†	20
1935 - 2	923	206	36.1	30	-	25
1935 - 3	695	109	13.6	13	*	86
1936 - 1	597	98	9.7	12	†	44
1936 - 2	972	210	32.7	31	-	74
1936 - 3	1161	150	26.5	29	†	59
1937 - 1	1252	130	22.8	18	-	26
1937 - 2	1294	259	45.5	37	-	16
1937 - 3	1055	160	21.3	26	†	27
1938 - 1	992	137	15.4	21	†	13
1938 - 2	1539	274	46.0	60	†	2
1938 - 3	1813	183	33.9	35	†	83
1939 - 1	2119	159	31.1	37	†	23
1939 - 2	2351	275	57.2	47	-	13
1939 - 3	2276	213	40.2	40	*	97

* Difference is too small to be noted.

T A B L E 6

THE RELATION OF VISION DEFECT (ACUITY, CORRECTED OR NOT,
MUSCLE IMBALANCE OR DEPTH PERCEPTION) TO ACCIDENTS

(Private Pilots)

Period Year-Thirds	No. of De- fects	No. of Acci- dents	Chance No. of Acci- dents with Defect	Actual No. of Acci- dents with Defect	Direction † is more actual, - is more chance	Probability of such a distri- bution by chance (out of 100)
1935 - 1	1279	90	21.6	29	†	7
1935 - 2	1168	206	45.7	41	-	42
1935 - 3	892	109	17.4	16	-	71
1936 - 1	768	98	12.5	18	†	9
1936 - 2	1253	210	42.1	42	*	98
1936 - 3	1533	150	34.9	42	†	16
1937 - 1	1629	130	29.6	24	-	24
1937 - 2	1720	259	60.5	45	-	2
1937 - 3	1401	160	28.3	33	†	33
1938 - 1	1308	137	20.4	31	†	1
1938 - 2	2045	274	61.1	79	†	1
1938 - 3	2402	183	45.0	50	†	38
1939 - 1	2789	159	41.0	48	†	20
1939 - 2	3085	275	75.0	63	-	10
1939 - 3	2929	213	51.7	57	†	40

* Difference is too small to be noted.

Tables 5 and 6 are read in the same manner as the previous ones. There are about as many periods showing^a zero or negative relation as those showing a positive one. The figures in the final column show that only one of these differences is reliable. The second period in 1938, where 46 accidents by pilots with defects would occur by chance yielded 60 actual accidents and this difference is sufficiently large so that it would occur only two times out of a hundred by chance. The second period in 1939, however, in which 57.2 accidents by pilots with defects would occur by chance, actually yielded only 47 and this difference is large enough so that it would occur only 13 times out of a hundred by chance. On the whole, Table 5 corroborates our rejection of the positive relation between visual defect and accident in Table 3 on the ground that it would occur nine times out of a hundred by chance. It is apparent that there is no relation between recorded defect in visual acuity and accident in this class of pilot.

Table 6 extends this lack of relationship to the other types of vision defect. In this table there are five periods showing a negative relation and nine periods showing a positive one. Three of the differences are large enough so that they would occur less than three times out of a hundred by chance. Two of these are positive and one is negative. Three other differences would occur ten or less times out of a hundred by chance. Two of these are positive and one is negative. If there is a relation between visual defect in general and accident among private pilots, it is so small that many thousands of cases will be necessary to portray it. It is also of such a vacillating character that it may occur in different directions at different times and, therefore,

must be subject to other conditions than defect alone. Age may be one of these conditions. Vision defect and age may have entirely different meaning from vision defect and youth.

The number of cases in the limited commercial class is so small, even for vision defects, that we are unable to portray a like analysis for this class of pilot. The difference, however, is so small that it would occur 52 times out of a hundred by chance, and this is good evidence that no relation exists between the defect and accidents.

Inspection of the counts themselves is convincing. There are only 35 accidents out of 1017 four-month flying experiences with defect. Since there are 433 accidents, taking total eligibility into consideration, we would expect 32 by chance. It is apparent that the three surplus is an unreliable basis for concluding that there is a relationship. This is, of course, what the 52 times out of a hundred by chance means.

It should be stated here that analysis of any of the other defects by period is impossible because of the small number of cases involved. It is pertinent to ask what types of material were used as a basis for the statement that there is a difference in rate of accident between pilots having defects and pilots who are free from the defect. After a study of five years, occasioning an intricate analysis of materials into four-month periods, we lack enough accidents with defect to allow definite conclusions with the possible exception of vision in two classes of pilots. A study based on such materials without the advantage of a very rigorous statistical classification would be subject to a great deal of error. ^{R.} Dean Brimhall has already commented in various places upon the application of such logic to fatalities. Less than ten percent of the

accidents analyzed in preceeding tables involved fatality and we were unable to make any study whatsoever of the relation of defect to fatality because so few fatal accidents of pilots having a defect are available. The human race has not been flying long enough to give us any such statistical picture.

T A B L E 7

THE RELATION OF VISION DEFECT (ACUITY CORRECTED OR NOT)

TO ACCIDENTS

(Commercial Pilots)

Year - Thirds	No. of Defects	No. of Accidents	Chance No. of Accidents with Defect	Actual No. of Accidents with Defect	Direction † is more actual, - is more chance	Probability of such a distribution by chance (out of 100)
935 - 1	415	165	9.6	8	-	59
935 - 2	459	253	16.3	17	*	86
935 - 3	466	168	10.8	8	-	37
936 - 1	458	176	11.3	17	†	8
936 - 2	476	275	18.3	13	-	23
936 - 3	473	182	11.8	11	-	81
937 - 1	538	146	10.9	12	†	72
937 - 2	423	278	16.2	13	-	40
937 - 3	509	178	12.2	16	†	25
938 - 1	497	147	10.3	7	-	28
938 - 2	573	244	21.1	15	-	15
938 - 3	646	212	20.8	13	-	7
939 - 1	425	184	11.6	8	-	30
939 - 2	447	278	18.6	14	-	26
939 - 3	543	195	16.0	11	-	19

Difference is too small to be noted.

T A B L E 8

THE RELATION OF VISION DEFECT (ACUITY, CORRECTED OR NOT, MUSCLE

IMBALANCE OR DEPTH PERCEPTION) TO ACCIDENTS

(Commercial Pilots)

Period Year-Thirds	No. of De- fects	No. of Acci- dents	Chance No. of Acci- dents with Defect	Actual No. of Acci- dents with Defect	Direction ‡ is more actual, - is more chance	Probability of such a distri- bution by chanc (out of 100)
1935 - 1	469	165	10.9	9	-	55
1935 - 2	521	253	18.5	20	‡	72
1935 - 3	524	168	12.1	10	-	52
1936 - 1	513	176	12.6	19	‡	6
1936 - 2	536	275	20.6	15	-	19
1936 - 3	532	182	13.3	11	-	51
1937 - 1	591	146	12.0	12	*	99
1937 - 2	467	278	17.9	14	-	33
1937 - 3	571	178	13.7	19	‡	13
1938 - 1	562	147	11.5	8	-	26
1938 - 2	651	244	24.0	16	-	3
1938 - 3	640	212	20.6	14	-	13
1939 - 1	482	184	13.1	9	-	23
1939 - 2	511	278	21.3	16	-	22
1939 - 3	621	195	17.8	12	-	14

* Difference is too small to be noted.

Table 7 presents an analysis of the relation of visual acuity to accidents in commercial pilots by period. Eleven of the fifteen periods show a negative relation. This bears out the conclusions reached from a consideration of Table 2. It is true that the differences are of such a size that they may easily occur by chance. However, as noted above, a consistent negative relation throughout the periods is added evidence to substantiate the significant difference pictured in Table 2.

Table 8 shows the relationship between visual defect of all types to accident in the case of commercial pilots. In the fifteen periods studied there are only two in which there is a probability better than ten out of a hundred that the association between visual defect and accident is more than chance. In one of these periods (1938-3) the accidents by pilots with a defect are less than would occur by chance. In the other period (1936-1) the accidents by pilots with a defect are greater than would occur by chance. In eleven of the fifteen periods the accidents by pilots with a visual defect are less than would occur by chance. In one period there is no difference (less than .05). In the last two years all six periods show fewer accidents by pilots with a vision defect than would occur by chance.

These statistics indicate a compensatory relation between visual defect and accident in the case of commercial pilots. It seems highly probable that a defect of this type makes an accident less probable than it otherwise would be. If similar materials could be developed for the other defects, as they cannot because of the limited number of pilots having a defect and an accident, we would expect, from Table 2 to find

similar negative relations. This is, however, a theory only since the statistical evidence is not adequate to make such computations and the material in Table 2 is not adequate to justify the assumption. We do point out, however, that we have covered five years and made every effort to take the greatest advantage of our materials and if we are unable to adduce evidence with these sources and such methods, we are certainly justified in doubting assertions of a positive relation such as have been made in the literature.

T A B L E 9

THE RELATION OF VISION DEFECT (ACUITY, CORRECTED OR NOT)

TO ACCIDENT*

(Solo)**

Period Year- thirds	No. of Defects	No. of acci- dents	Chance No. of accidents with Defect	Actual No. of acci- dents with Defect	Direction ‡ is more actual, - is more chance	Probability of such a distribution by chance (out of 100)
1938-1	166	3	.6	0	*	
1938-2	240	47	7.4	9	‡	52
1938-3	316	45	6.2	9	‡	22
1939-1	425	52	5.5	5	*	81
1939-2	568	100	10.9	8	-	34
1939-3	691	111	12.2	24	‡	less than 1

** Only two years of this classification available

* Difference is too small to be noted

T A B L E 10

THE RELATION OF VISION DEFECT (ACUITY, CORRECTED OR NOT,

MUSCLE IMBALANCE AND DEPTH PERCEPTION)

TO ACCIDENT*

(Solo)**

Period Year- Thirds	No. of Defects	No. of Accidents	Chance no. of accidents with Defect	Actual No. of acci- dents with Defect	Direction ‡ is more actual, - is more chance	Probability of such a distribution by chance (out of 100)
1938-1	217	3	.8	0	*	
1938-2	316	47	9.8	14	‡	12
1938-3	419	45	9.2	11	‡	27
1939-1	568	52	7.4	8	*	81
1939-2	742	100	14.3	10	-	22
1939-3	886	111	15.6	29	‡	less than 1

Tables 9 and 10 present evidence by period of vision defect in relation to accident at the solo stage. Materials for two years only were available. Inspection of these materials corroborates the conclusion reached from Table 1. In each table, four of the six periods show a difference over one between actual and chance. Three out of four of these relations are positive in both tables. The difference in the last period of 1939 is very large and significant.

** Only two years of this classification available

* Difference is too small to be noted.

This indicates a liability to accident in the solo stage for pilots with a visual defect. Since such liability is not found in any of the other stages, it prompts further investigation of its causes. The variation in the relationship between periods also prompts an investigation of correlated conditions. It suggests that the defect alone is not provocative, that it must be associated with other conditions before it becomes a menace to safety.

We would like to compare accident-defect classifications in respect to other factors such as age. Are pilots who have a defect and an accident older than pilots who have an accident but no defect? Are they older than pilots who have a defect and are flying in that period but have no accident? Are they older than pilots flying in that period who have neither a defect nor an accident? Unfortunately, however, the material is available for two classes only, - those who have a defect and an accident and those who have an accident but no defect. This will enforce severe limitations upon our interpretation. We are able, however, with some speculation to indicate a probable interplay of factors.

T A B L E 11

AGE OF SOLO PILOTS WITH ACCIDENT RECORDS

<u>Age-years</u>	<u>Percent of 58 pilots having vision defect at time of accident</u>	<u>Percent of 265 pilots with no record of defect of any kind</u>
20 & under	9	14
21 - 25	14	30
26 - 30	24	25
31 - 35	22	17
36 - 40	10	8
41 - 50	12	4
over 50	9	1
Total	100	100

Chi-squared = 24.5

P = .0004

Table 11 shows the age distributions of solo pilots at the time of accident. It is apparent that those with a defect are older than the others. Disparity as large as this would occur by chance less than four times out of ten thousand. Now, if we knew that the group having an accident and a defect was also older than the group having a defect but no accident, we could conclude that age and defect in combination prejudice toward accident.

The alternative assumption would be that all defect cases are older, irrespective of accident occurrence. At the commercial stage this assumption is tenable but at the solo stage it is more doubtful. We, therefore, conclude that age and vision defect together may represent a handicap to flight training. This is not unreasonable. Adaptation to vision defect in new learning processes becomes progressively difficult with age. This must necessarily follow from the many compensations which are acquired and become barriers to new learning.

T A B L E 12

AGE OF COMMERCIAL PILOTS WITH ACCIDENT RECORDS

<u>Age - years</u>	<u>Percent of 190 pilots having vision defect at time of accident</u>	<u>Percent of 2386 pilots with no record of defect of any kind</u>
30 years & under	27	45
31 - 35	32	27
36 - 40	21	18
41 - 45	11	8
over 45	10	2
Total	100	100

Chi-squared = 53.1

P = .000000

T A B L E 13

AGE OF PRIVATE PILOTS WITH ACCIDENT RECORDS

<u>Age - years</u>	<u>Percent of 542 pilots having vision defect at time of accident</u>	<u>Percent of 1625 pilots with no record of defect of any kind</u>
20 & under	3	8
21 - 25	16	21
26 - 30	23	28
31 - 35	19	18
36 - 40	13	15
41 - 45	10	7
46 - 50	7	2
over 50	9	1
Total	100	100

Chi-squared = 153.3

P = .000000

Table 12 presents the same age comparison for commercial pilots. Differences in age distribution as large as this between vision defect and non-defect groups both of which have had an accident would occur only once in a million chance arrangements. However, in this group it seems very probable that vision defect and age are associated entirely apart from accident. The defect group who did not have an accident are probably older than the non-defect group who did not have an accident.

This assumption arises from our knowledge of the deterioration of vision with age and the negative relation between defect and accident liability among commercial pilots.

In any case vision defect groups who have accidents are older than are other pilots having accidents. This is true of all classes. Table 13 shows the same discrepancy for private licenses. Again the difference in distributions is so large that it would occur in chance arrangements less than once out of a million. It seems clear from Tables 3, 5 and 6 that the defect alone is not a handicap in this class. But age together with defect might still be correlated to accident. We repeat that the evidence necessary to put this to a crucial test is not now available.

To summarize: In consideration of the negative relation existing between vision defect and accident in commercial pilots, it seems probable that here neither age nor defect is related to accident but only to each other. Indeed this may be equally true among the private pilots. But in the case of solo pilots, where there is a positive relation between defect and accident, and the defect plus accident pilots are significantly older, there is a very good chance that age accentuates the vision defect liability to accident. Age and defect together may very well be a handicap to learning, but not to continuation of developed abilities.