jerky movements of the arms; another individual gives an occasional little nervous cough or grunt, and so on. Then again, one variety of stammering, in which the patient sticks in the middle of a vowel (less common than the type where he sticks over a consonant) is simply a respiratory tic affecting the muscles of the false vocal cords. Examples of tics or habit-spasms of this sort might easily be multiplied, and many of you can recall for yourselves friends or patients who perform peculiar respiratory actions of this sort. A tic or habit-spasm, it should be remembered, is a psychomotor affair of cortical origin, consisting in the frequent explosive repetition of the same motor act. It never interferes with voluntary movements. Sometimes the tic takes place automatically and without the patient's conscious attention; in more severe cases the tic absorbs the patient's attention during its performance, and is accompanied by a feeling of irresistible compulsion. The greater the psychical abnormality the more violent does the tic tend to be.

THE NOSE, THROAT, AND EAR REQUIRE- MENTS OF AIRMEN.

PROBLEMS PRESENTED BY THE INTERNATIONAL
MEDICAL REQUIREMENTS FOR AIR NAVIGATION,
WITH SPECIAL REFERENCE TO THE NOSE,
THROAT, AND EAR.

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THAT the airman should be medically fit is a dictum that none can deny. It stands to reason that anyone subject to rapid changes of atmospheric pressure and with such physical responsibilities as are demanded of a pilot should be organically sound, especially in regard to the nose, throat, and ear. All aviation medical boards, therefore, have laid down standards which, in the early days—when indeed there was often little or no medical examination of flying personnel—were mostly arbitrary, but which became modified from time to time as knowledge was acquired of the physiological attributes essential for successful flying.

The object of this paper is to discuss such physiological attributes in regard to the nose, throat, and ear, and to draw attention to the process by which these standards are being confirmed or refuted. With more than four years' experience in the examination of candidates, I know of many instances where the question of acceptance or rejection of an individual has produced sound arguments on both sides; in consequence, it has seemed to me of interest and value to consider some of these cases, more especially in the light of the international medical requirements for civilian pilots. It is necessary to pass in review the experiences upon which such requirements were undoubtedly founded.

The Aviation Candidates Medical Board of the Royal Air Force insists that candidates with no previous experience of flying shall have hearing in either ear equivalent to a forced whisper at a distance of 20 ft.; perforations of the drum, chronic suppurative otitis media, and a radical mastoid operation; successful or otherwise, are causes for rejection. These are excellent safeguards; a fair number of pilots who—either inadvertently or before the Aviation Candidates Medical Board was established—were instructed in flying, were then found to have trouble in the air, and have since been invalidated out for one or other of the reasons cited above. They frequently suffered from dizziness or headaches, sickness or exacerbations of chronic suppurative otitis media, pain or ringing in the ears, and there was always the chance of labyrinthine involvement through a necrosed inner wall of the middle ear. The experience of the medical services of other countries has been similar. It is

better, therefore, not to take initially the risk of these complications, but where no trouble has arisen over a period of years it becomes a matter for careful thought as to what decision to make.

The International Medical Requirements.

As stated above, many of the rules laid down by Aviation Candidates Medical Boards were in the first place empirical, but the international medical requirements differ in being succinct, and in virtue of what they definitely contain, or perhaps purposely omit, are capable of wide interpretation according to the views prevailing in any particular country. The following are those laid down for the nose, throat, and ear:—

“Ear Examination.”—The middle ear must be healthy. The aeronaut must possess a degree of auditory acuity compatible with the efficient performance of his duties.

Vestibular Mechanism.—Must be intact and neither unduly hypersensitive nor hyposensitive.

Nose and Throat Examination.—The aeronaut must possess free nasal entry on either side and not suffer from serious acute or chronic affections of the upper respiratory tract.

Each contracting State for the present is to fix its own method of examination and no aeronaut who has given proof of his flying ability shall, so long as he retains such ability, be necessarily disqualified because he fails to fulfil all these requirements.”

I wish to call particular attention to this latter clause. Let us now consider these requirements seriatim.

A Healthy Middle Ear.

It was probably felt that external ear and meatal conditions could be left to the discretion of the examiner, but that there could be no dispute as to rejection where pathology is present in the middle ear. I have accordingly taken the records of 450 civilian, or rather would-be civilian, pilots for passengers or goods examined by myself since the armistice; these are the findings in cases where the middle ear was not healthy:—

1. L. Has flown 600 hours during the war. Is now deaf in left ear; a dry perforation on that side. Possible initial date of ear trouble, May, 1918. Became troubled with giddiness in the air in March and April, 1919. This candidate would, no doubt, be unsafe as a civilian pilot and he was accordingly rejected.

2. C. 1050 hours previous flying. A small posterior inferior perforation of left drum, and left ear has discharged off and on during last 12 years—i.e., trouble commenced long before he learnt to fly. Although middle ear was not healthy, and never likely to be so without operation, absence of symptoms with a good flying record was satisfactory, and he was accordingly accepted.

3. M. 500 hours previous flying. Chronic suppurative otitis media both ears, date of origin unknown. Hearing right ear fair but only 1 ft. for a forced whisper in left ear. Candidate deferred for aural treatment, never previously having had any, but failed to present himself for re-examination.

4. K. 300 hours previous flying. Right ear has discharged off and on since childhood; forced whisper heard at a distance of only 4 ft. on that side; large dry perforation in right tympanic membrane. A view similar to that in Case 2 was taken, and he was accepted.

5. B. Has flown over 2000 hours; airman by profession. Ears have run off and on since childhood; hearing good in either ear, right drum scarred; a large posterior inferior perforation in the left drum. Assessment similar to that made in Case 2.

6. S. Number of hours flown about 1250; a discharge from left ear off and on since age of 12. Hearing on both sides good, but right drum opaque; an anterior perforation of left drum. Candidate accepted.

7. T. Has flown more than 1000 hours. In 1914 left ear discharged, and has run off and on since. Hearing good in either ear, but a posterior superior scar in left drum. Candidate accepted.

Bearing in mind the frequency of breakdown of pilots suffering from a like condition, the outstanding feature of the above and subsequent cases is, I think, adequate illustration of the fact that in certain people the bodily mechanism can, for a time at any rate, rise superior to serious physical defects. A consideration of the above cases shows, moreover, the wisdom of a saving clause as to previous flying ability. It was felt that five of the seven candidates described

above had given such proof of flying proficiency that it would be manifestly unfair not to accept them at once in spite of their disabilities, especially in the absence of any present or past complications of their disease. Their middle ears were not healthy, but they had always been serviceable enough for efficiency, and the public would have been losers by the rejection of such men. It should here be added that particular stress is laid during the examination on a concomitant search for any internal ear trouble that may be present, as also on the presence or absence of exacerbations of middle-ear disease at any time in the past history. The regulations also provide an additional safeguard—viz., periodic medical examinations at maximum intervals of six months.

Auditory Acuity.

What is efficient flying auditory acuity? The importance of hearing to airmen lies largely in the fact that they may be able to detect engine defects and to use telephones, but of course hardness of hearing is a serious handicap to success in almost any trade or profession. The following are among those who presented themselves for examination:—

1. P. Had 2300 hours previous flying. Hearing nil in right ear, normal in left. Right ear trouble, dating from age of 10, due to an old chronic catarrh. As a fighting pilot this man would have been at a disadvantage in having imperfect ideas of direction of sounds, such as those made by shells and bullets, but because of his past record he was considered quite trustworthy as a civilian pilot, and was accepted.

2. P. In civil life an airman and engineer, 2000 hours previous flying. Right drum retracted and opaque, but good hearing on that side. Left ear ran in childhood; hearing practically nil on this side, there being an old healed suppurative otitis media with a retracted adherent membrane. Same view taken as in Case 1.

3. S. In civil life an airman, 3000 hours previous flying. Right ear absolutely deaf for last nine years; no reason could be given or cause found. Left ear normal. Similar view taken as in Cases 1 and 2.

4. K. In civil life a test pilot, 3000 hours previous flying. Hard of hearing in both ears from childhood; hears a loud voice in right ear at a distance of only 2 ft., and in left ear at a distance of about 1 ft. Both drums retracted, scarred, and opaque, but no signs of active disease. Vestibular reactions are normal. Particularly alert, a good lip-reader, and has excellent testimonials from his firm. Flown successfully for five years, instructed for a considerable time at a civilian school, acted in the army as instructor, test pilot, and ferry pilot, and since 1917 has tested all experimental machines and numerous others of a well-known firm.

This last-mentioned case of bilateral hardness of hearing is particularly interesting; in spite of his handicap the airman learnt to fly successfully, and confidently asserts that he can at once detect any change in the noise of his engines. He is of exceedingly active mentality and his other senses are extremely acute. He was accepted in view of the previous successful flying history.

Vestibular Mechanism.

If by "intact vestibular mechanism" is meant a vestibule where no pathological process is or has been present, candidates whose vestibular mechanism is or has been so involved should be rejected. The phrase "unduly hypersensitive or hyposensitive" is open, however, to much more dubiety, and in the present state of our knowledge there are diverse opinions as to its correct definition. According to Colonel Isaac Jones, in his book entitled "Equilibrium and Vertigo,"¹ the Americans during the war laid very great stress on the Bárány tests, and actually rejected candidates with a nystagmus period of under 16 seconds or over 36 seconds, after a period of rotation to right or left, consisting of ten turns in 20 seconds. They have apparently modified this arbitrary rule, according to their official publication of February, 1920.² In regard to efficient service pilots at the front, Sydney Scott showed that the reactions of the semi-circular canals do not serve to indicate a pilot's flying ability,³ and Bilancioni says that in normal individuals the nystagmus varies between extremely wide limits.⁴

In a paper of my own on the subject of labyrinthine reactions published last year⁵ I showed that some of our most experienced pilots failed to satisfy American rotation standards, and concluded that "in the absence of a discovery of present or past signs or symptoms pointing to an aural affection, routine examination by means of the Bárány tests is superfluous, provided that a thorough medical examination is made." With regard to rotation tests, the Aviation Candidates Medical Board of the Royal Air Force is inclined to lay very much more stress on the ability to perform certain simple acts immediately after a period of rotation, as also on a history pointing to hypersensibility to motion in trains, swings, or ships—i.e., to what are apparently excessive labyrinthine symptoms; such hypersensibility is always carefully noted and a thorough labyrinthine examination made, especially of individuals who have trouble while flying or are without previous flying experience. In connexion with the ability to fly with an apparently unsatisfactory condition of the labyrinthine mechanism the following two cases of civilian pilots examined are interesting:—

1. B. Previous flying hours, 900. Never could stand the sensation on swings and merry-go-rounds, and always feels ill at sea. Impossible to carry out Bárány tests on him, because on rotation he immediately felt ill and begged to be stopped. Nose, throat, and ears normal, Eustachian tubes pervious. Had a crash in October, 1916, with slight concussion, and since suffered at times from nervous debility. In 1919 flew successfully as a pilot; the history of concussion places one in doubt as to whether the symptoms were purely cranial, or labyrinthine, or both. Incidentally he was a heavy cigarette-smoker.

2. K. Number of flying hours, 250. In spite of this cannot stand being rotated; very quickly feels ill, and in boyhood never liked swings or roundabouts, being too much upset by the motion. No cause could be found for this hypersensibility which, however, has not interfered with his flying career.

The above two cases could be multiplied, but it must be remembered, and indeed practically every experienced pilot will agree, that the motion and effects of the rotary chair are quite different from those of an aeroplane, and the symptoms produced thereby very much greater and more intense. It is almost impossible to make a fair comparison of the two forms of motion, as the chair, unlike the aeroplane, spins round in a small axis in the horizontal plane, and also because the labyrinthine effects produced thereby arise most markedly just after rotation is stopped, there being, of course, no such deliberate stoppage of an aeroplane.

We now turn our attention to the nose and throat, and consider the regulations, or rather indications, with reference to the state and fitness of the upper respiratory tract. It is here, indeed, that we find in practice most exception to theoretical considerations. "The aeronaut must possess free nasal entry on either side" say the international requirements: "mouth-breathing constitutes a serious flying disability" says the Aviation Candidates Medical Board, R.A.F. My statistics of these 450 experienced pilots tell us, however, that 32 of them were mouth-breathers in all degrees ranging from partial or occasional to permanent, and that only one of these 32 was rejected on medical grounds and then not because of mouth-breathing; the other 31 were good pilots with good records and were deservedly granted licences.

Free Nasal Air-entry and Mouth-breathing.

For the moment it will be convenient to consider the above 32 cases together; later it will be necessary to consider others where mouth-breathing was definitely secondary to a cause obviously present at the time of examination in the nose or throat and almost crying out for remedy. In the cases of these 32 it was rather different; in some there was an associated more or less marked septal deviation, and in others diseased or hypertrophied tonsils or adenoid remains were discovered; but it must be said that not one of them had any other signs or symptoms of nose and throat disease. In these cases one did not feel justified

in recommending operation; some had already had operative interference with little amelioration as regards their mouth-breathing, and in some no vestige of a possible cause could be found and the condition was evidently a bad habit, and also, it must be said, not a very marked one.

Mouth-breathing per se is presumably a disability because of the frequently associated parched buccal and pharyngeal mucous membrane, spongy gums, or excitation produced by currents of air on carious or ill-stopped teeth or unhealthy tonsils. These symptoms are much more pronounced in some individuals than in others, and quite a number of mouth-breathers neither have nor complain of any discomfort. One must remember also that mouth-breathing itself is only a symptom, sometimes, but by no means always, associated with other physical or skeletal conditions such as deformed chest or highly arched palate. Again, nearly all pilots above a height of 12,000 ft. begin to breathe through their mouths in order to obtain sufficient oxygen from the rarefied atmosphere. The conclusion to be drawn, therefore, is that there are quite a number of pilots in whom mouth-breathing constitutes apparently no disability at all and that the assessment of any symptoms due to it is the important point.

Deviated Septum.

There is a small but distinct group of cases among these 450 experienced airmen in which nasal examination seemed to leave one no alternative but to say that submucous resection should be performed irrespective of the candidate's history of symptoms as given by himself. In this connexion one must remember that there is a marked tendency on the part of examinees to pooh-pooh any discovered apparent disability as having given rise to no, or at any rate, to only slight, trouble in the past. It must be remembered, on the other hand, however, while giving due weight to such a history, that symptoms apparently trifling in importance on the ground tend to become considerably aggravated in the air. Deviated septum, traumatic in origin, is of fairly frequent occurrence among experienced pilots, sometimes because of their sporting instincts in the way of boxing or the rougher games, but more so because of their liability to crashes with trauma about the face and head. In this class I must place six airmen out of the total number seen, not only because examination at once suggested the need for correction, but more so because of the concomitant symptoms. Frequent colds in the head with mouth-breathing were usual symptoms, obstruction in one or the other nasal passage was practically always present, while two were subject to attacks of hay fever. In spite of these signs and symptoms, however—i.e., acute and chronic affections of the upper respiratory tract and absence of free nasal air-entry on one or the other side—three of these airmen had successfully flown over 1000 hours, and the remaining three 150, 400, and 600 hours respectively. There can be little doubt that submucous resection would add materially to their comfort and well-being, and indirectly therefore to the longevity of their flying life.

Enlarged or Unhealthy Tonsils and Adenoids.

Ten airmen were found in whom signs and symptoms, such as marked hypertrophy, frequent sore-throats or attacks of quinsy, enlarged glands in the neck, and in the case of adenoids repeated colds and occasional attacks of Eustachian tube obstruction, left no doubt that operation would be an advantage. A large number of others with unhealthy tonsils was seen, who, on their own statement, had never had any trouble. These ten airmen, in spite of their symptoms, had flown periods ranging from 140 to 2700 hours. In this connexion I mention a well-known stunt pilot and instructor who, besides having a tendency to mouth-breathing with distinctly unhealthy tonsil remnants present, had a history of occasional migraine attacks, and also possessed visual defects. This pilot had flown 1550 hours, had been up to 23,000 ft. with no discomfort and without

oxygen, and apart from a gunshot wound in the left leg in 1915 had never suffered from any disability!

Miscellaneous.

In this group I have placed four airmen. Two suffered from hay fever every year without any flying trouble. Both had flown successfully about 1500 hours. A third was subject to frequent colds and evidently had a very susceptible mucous membrane: when seen, the whole of the upper respiratory tract was in a condition of acute catarrh without any apparent clinical evidence of the cause. In spite of this he had flown 900 hours successfully. A fourth suffered from atrophic rhinitis probably due to too extensive turbinal operation in civil life, but had, nevertheless, flown 150 hours without discomfort or mishap.

Conclusion.

I have considered the above groups of cases because, although various aural or upper respiratory tract potential disabilities were present, the flying efficiency of the airmen concerned has been proved over and over again; I feel, however, as stated above, that it would be both wrong and misleading to quote such cases without again emphasising the point that in my opinion these airmen were successful *in spite of* their defects, and I cannot doubt that their standard of excellence would have been higher had they conformed to the normal. What really does matter, and probably happens in all such cases, is that a power of compensation exists and minimises any potentially troublesome defects. The same remarks might be made with regard to refractive errors in cases of maimed or partially disabled pilots and with respect to other physical conditions diverging from the normal. Such emphasis is perhaps necessary, as medical boards in all parts of the world have laid down stringent standards for untrained would-be aviators; tempered with discretion and discrimination, however, on the part of medical examiners there can be no doubt that this is, and has been, the right and wisest course to pursue.

Should any relaxation of medical standards be made when the demand for pilots exceeds the supply in the case, say, of another great war? If so, in what direction should this relaxation take place? Writing with respect to the nose, throat, and ear it is apparent that apart from a number of candidates who might be temporarily deferred for operative treatment, the debatable cases would be men with chronic suppurative otitis media with or without hearing defects, who were in other respects perfectly healthy. In a recent paper of mine entitled "The Incidence of Nose, Throat and Ear Disease among Aviation Candidates," I showed that only about 3.6 per cent. of the young men presenting themselves as aviation candidates suffer from aural disease, so that the number of such cases would be small; were it necessary to consider the question of admitting some of these candidates, and, in my opinion, this would only be justified under very extreme conditions, it seems that the presence or absence of symptoms or exacerbations of disease over a preceding lengthy period of years should play an important part in the adjudication; other things being equal, however, it would appear incontrovertible that a candidate sound and healthy in all respects is more likely to be useful and successful over a period of years than one with any physical defects, however unimportant the latter may seem to be at the time of examination.

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