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MEDICAL ASPECTS OF BOXING, PARTICULARLY FROM A NEUROLOGICAL STANDPOINT*

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Traumata arising in the course of boxing contests or during a pugilistic career are diverse in character. Whether they are to be regarded as commendably rare or as alarmingly common is a matter of opinion. It is sometimes claimed that boxing *per se* causes no more injuries or fatalities than some other sporting events. Thus Johansen (1955), of Oslo, has analysed a series of 6,057 sport injuries occurring during the period 1946-8: of these, boxing, which came tenth out of a list of 14 athletic pursuits, was held responsible for only 100 accidents (1.65%). This contrasts with the numbers attributed to skiing (1,784, or 29.4%) and to football (1,320, or 21.8%).

One important distinction, however, distinguishes boxing from most other forms of athleticism. Injuries are coincidental in other sports, but in boxing the aim and object—explicit or implied—is to render the opponent *hors de combat*. Traumata are therefore not so much regretted as regrettable.

This paper makes no plea either for or against pugilism. Amateur boxing can certainly fulfil many useful purposes, sociological as well as personal. Whether the benefits of amateur boxing outweigh the drawbacks is a question for others to decide; while some may well consider that professional pugilism forms a problem all of its own. The purpose of this communication is merely to enumerate some of the principal ill effects which have been ascribed to boxing, with particular reference to the neuro-psychiatric deterioration which may develop late in the career of a prize-fighter.

The "Knock-out"

The "knock-out"—so dramatic a spectacle in professional contests—entails the deliberate and violent production of a state of motor hypotonus and helplessness coupled with a severe—if short-lived—disturbance of consciousness. As a rule this knock-out phenomenon is the result of a violent blow to the point or side of the chin. The victim collapses heavily and remains immobile or inert for a matter of seconds or minutes. The unconsciousness produced by the knock-out blow is clinically rather unusual, being as a rule very abrupt in onset, quite short in duration, and comparatively complete in recovery. In falling, the head may forcibly strike the ground, thereby producing a second and direct injury to the head which of itself may complicate the clinical picture. If the boxer is rendered so helpless as to be unable to regain the erect stance within 10 seconds, he is "counted out." After a knock-out blow most boxers

are able to leave the ring within a minute or two, though ordinarily with the help of their seconds. Longer periods of powerlessness, or of unconsciousness, are by no means unknown, however.

According to the sporting fraternity there are causes of a knock-out other than a blow to the chin. Thus there is the "solar plexus knock-out," which is not ordinarily attended by unconsciousness. Jokl (1941) believed that this type of injury is identical with the experimental *Klopfversuch* studied so thoroughly by Goltz (1863). There is also a "heart knock-out" (or *commotio cordis*), which on occasion has proved fatal. Blows to the side of the neck may provoke what physicians may regard as a "carotid sinus knock-out." The physiological mechanism of this lesion has been particularly associated with the work of Hering (1927). According to Boigey (1938), the right side of the neck is more sensitive to blows than the left, so far as the carotid sinus is concerned. There are, in addition, certain types of foul punch which are apt to produce a knock-out. These include a downward chop to the nape of the neck (rabbit punch); blows "below the belt" (a euphemistic term for direct injury to the testicles, which is apt to produce much pain, shock, and occasionally unconsciousness); and "kidney punches," which have been known to provoke haematuria and even renal lacerations.

The ordinary classical knock-out blow is, however, an indirect head injury, where the point of impact of the fist is to the "button"—that is, the point of the chin. The violence is transmitted up and back to the base of the skull. The exact mechanism of the loss of consciousness and tonus has been a source of controversy. Sherrington's (1906) description deserves quotation: "The 'knock-out blow,' where the lower jaw conveys concussion to the otocyst, reduces in a moment a vigorous athlete to an unstrung bulk of flesh whose weight alone determines its attitude, if indeed a reactionless mass can be described as possessing attitude at all." It is interesting to note that Sherrington did not mention disordered consciousness. In other words, concussion of the otocyst is—in his opinion—the essential factor of the knock-out, leading to an abrupt hypotonus of vestibular origin. Somen (1913-14) also implicated the inner ear; and, according to Somen, Babinski concurred. La Cava (1952) believed that a violent blow to the mandible involves nerve structures immediately behind the angle of the jaw, and leads to an abrupt drop in blood pressure. Denny-Brown and Russell (1941) visualized a sudden stimulation of vasomotor centres leading to a temporary depression in cardiac, vasomotor, and

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respiratory function. Jokl (1941), like Winterstein (1938), also imagined a condition of mechanical medullary dysfunction which may be complicated by concussion due to the direct effect of the fall.

More precisely Jokl and Winterstein (and also Gonzales, Vance, and Helpen, 1937) believed that a blow to the chin produces a two-phasic jerk which involves the medullary centres. In the first place, the clivus and the anterior edge of the foramen magnum impinge violently against the pons and upper medulla; while during the second phase, by virtue of a *contre-coup*, the medulla bounces back against the occipital bone and the posterior edge of the foramen magnum. Gonzales *et al.* described this double impact as "oscillation" of the brain.

The investigations made by Larsson *et al.* (1954), though not conclusive, are rather against any theory that a drop in blood pressure is the *modus operandi* of the knock-out, suggesting that the factors responsible are essentially concussive in type.

Other hypotheses about the cause of the knock-out include that of Flint (1920), who imagined that a distortion of the jaw mechanically impinges upon the carotid artery and so produces a temporary cerebral anaemia. Pfeiffer (1922) implicated a mechanical and short-lived obstruction of the jugular vein.

Amnesias due to Boxing

Just as different types of knock-out can be isolated, so too one can identify a number of different types of amnesia or loss of memory in association with boxing. Thus there may be a period of retrograde amnesia immediately preceding the spell of unconsciousness due to a knock-out. Sometimes there is a more lengthy period of retrograde amnesia, so that the boxer afterwards has no recollection whatsoever of any events of that particular contest. Indeed, he may not be able to remember that the fight even began. This amnesia is of course permanent. Then there are the anterograde amnesias where the pugilist goes on fighting after a knock-out, but without subsequent recollection thereof. This is the groggy-state automatism. Quite independent, of course, is the gross day-to-day memory-defect of the dementing punch-drunk victim. These phenomena are described below.

Other Injuries from Boxing

It does not come within my province to describe in detail the various surgical injuries which have been reported as consequent upon amateur or professional boxing. Some of them are admittedly quite rare, such as ruptured muscles, fractured arm, arteriovenous aneurysm, direct damage to a single nerve—for example, the facial nerve or the long thoracic nerve of Bell (the "commotio nervi" of Jokl). Quite unspecific is the occurrence of bouts of vomiting ("athlete's sickness") which may follow any violent physical exertion. Other injuries are so commonplace as to constitute the ordinary occupational marks of an experienced pugilist. Here belong such physical signs as the cauliflower ear, the flattened nose, hypertrophied superciliary ridges, and arthritis of the first metacarpo-phalangeal joint.

Injuries to the eyes are much more serious and more varied in character. They have been well described by Doggart (1951, 1955) in this country and by Favory and Sédan (1951) in France. Just how common they are in the course of a boxing career has not been made clear. Among the injuries listed by Doggart are, first, damage to the *outer eye*. Here belong trauma to the conjunctiva and to the cornea, folding or rupture of Descemet's membrane, and scleral rupture. Secondly, a great diversity of lesions of the *inner eye* may occur. These include tears of the iris, perhaps involving the sphincter muscle of the pupil. Persistent hypotony may result from lesions of the ciliary body. Chronic iridocyclitis may develop, and go on to a phthisis bulbi. Accommodation may be paralysed. The lens of the eye

may be subluxated or dislocated. Cataract is not uncommon. Haemorrhage into the vitreous may take place, and, though it often resolves satisfactorily, it may lead to a retinitis proliferans. Retinal detachment, which may be bilateral, is a disastrous complication, for it is only rarely amenable to surgery. Cystic and pigmentary changes at the macula and retinal or choroidal haemorrhages may also occur.

Doggart draws special attention to irregular patchy choroidal degeneration in boxers, a feature which he speaks of as "cauliflower choroids." Optic atrophy, avulsion of the optic nerve, haemorrhage into the nerve sheath, and recurrent congestive glaucoma are among some of the other disastrous sequelae that have been described as due to boxing injuries. Doggart finally enumerates injury to the neighbouring structures: fractures of the orbit, periosteal thickening, orbital emphysema, damage to the lacrimal gland or duct. Implication of any of the ocular muscles may occur, especially the superior and inferior obliques.

Boxing Fatalities

Injuries sustained in the ring have ended fatally. Just how the recorded figures strike one depends mainly upon the prejudices and emotions of the reader. Thus, Blonstein and Clarke (1954) have spoken of six deaths over the course of seven years' experience—all in the course of amateur boxing. Kaplan and Browder (1954) have had 26 years' medical experience of the professional ring and have assisted at the necropsy study of five cases. Jokl (1941) went into the published statistics in some detail. He said that Flint (1920) had stated that 124 fatal cases had been recorded up to that time. Since then Jokl had been able to collect another 41 cases between 1920 and 1938. According to Steinhaus (1950b), in the four years prior to 1950 42 professional boxers and 22 amateurs had died from occupational injuries. While the total to the end of 1956 is uncertain, we can say that, up to 1950, at least 207 fatalities had been recorded.

Most of the deaths were due to subdural haemorrhage; some to intracerebral bleeding. At times a heavy fall on the back of the head in the ring was held responsible, rather than blows to the face by a gloved fist. In some cases necropsy demonstrated an innate and unsuspected thinness of the cranial bones. The youthful age of some of the victims is striking—for example, 16 years (case of John Shoddy, 1951); 15 years (Weimann, 1931; Berg, 1933; Kappi, 1938), and 13 years (case of David Zimmerman, 1951). Quite a number of these fatalities had occurred in amateurs and not professionals. In some of them, death had occurred from a blow struck in the first round of a contest.

Besides these deaths from haemorrhage, there are the rarer cases of "reflex death" and "fatal commotio" which may or may not be associated with status thymolymphaticus.

The Punch-drunk State

To a neurologist the chief interest centres in those experienced boxers, whether amateurs or professionals, who have undergone gradual physical and mental deterioration as a direct accumulated result of their careers. This is the condition popularly termed punch-drunkness. We do not know who it was first coined the term "punch-drunk." Probably it was a layman. Its introduction into the medical literature dates from the paper by Martland in 1928. Since that time it has established itself in medical terminology, and a not inconsiderable literature has developed. The term has also become well known to the laity, and in sporting circles certain pejorative—almost derisive—connotations have become attached both to this particular word and to its synonyms "punchie," "goofy," "slug-nutty," "paper dolls," "stumblebum," and "slap-happy." For such reasons attempts have been made to introduce a more esoteric and less offensive expression. Thus we have "traumatic encephalopathy" (Parker); "traumatic encephalitis" (Ravina); "dementia pugilistica" (Millsbaugh); "chronic brain injury after boxing" (Bøje). If we really require a suitable scientific alternative to "punch-drunkness" we may perhaps adopt the

term "chronic progressive traumatic encephalopathy of boxers."

Up to date, my own neurological experience has comprised a series of 69 cases of chronic neurological disease in boxers. Many of these—perhaps the great majority—should be looked upon as examples of punch-drunkenness, either early or well established. In only a comparatively few cases does legitimate doubt occur about the possibility of there being some coincidental and non-related nervous or mental disease—for example, epilepsy; psychopathy; presenile dementia; cerebral arteriopathy.

The details of the boxing careers in punch-drunk patients are significant. Punch-drunkenness is much commoner among professionals than among amateurs. It is commoner in second-rate or third-rate performers than in the intelligent scientific exponent with a championship title. It is very rare in coloured boxers. As fighters, the punch-drunk ex-pugilists have been slow on their feet rather than nimble, and notorious as being able to "take it." They can perhaps be looked upon as "sluggers" rather than scientific boxers. Punch-drunken states have been found in fighters of all weights, but most characteristically in small men who had not been particular about the size of their opponents, having often taken on contestants heavier than themselves. There is a correlation between the degree of cranio-facial marking and the intensity of the punch-drunk syndrome. The sum total of contests is important, as well as the number of occasions upon which the boxers have been rendered unconscious. Being "knocked out on the feet" is perhaps just as significant as being flogged.

Of special aetiological importance is that humbler side of boxing where the contestant travels in fairs in the boxing-booth (or "blood-tub"), taking on all-comers at any weight. Almost as characteristic is the story of the boxer who eventually gives up the ring, having failed to make the grade, later to become what they call a "punch-bag"—that is, one of a team of sparring partners to a first-class heavyweight. A typical story is that the boxer, after a promising early career in the ring, begins to slow up; to be knocked out more often; to win fewer contests; and to be seedy for increasingly longer periods after each affray. Most characteristic of all is the admission on the part of the boxer that he finally abandoned the ring because of his wife's increasing disapproval of his career.

The symptoms and signs of a punch-drunk state are varied, but there are certain clinical features which underlie all the diverse patterns of the disease. As a rule, gradual evolution of mental and physical anomalies marks the insidious onset of the encephalopathy. Among mental symptoms there is the slow appearance of a fatuous or euphoric dementia with emotional lability. The victim displays but little insight into his deterioration. Speech and thought become progressively slower. Memory deteriorates considerably. In Service experience there is a falling-off both in efficiency and in conduct. There may be mood-swings, intense irritability, and sometimes truculence leading to uninhibited violent behaviour. Simple fatuous cheerfulness is, however, the commonest prevailing mood, though sometimes there is depression with a paranoid colouring.

From the clinical standpoint, the neurologist may encounter almost any combination of pyramidal, extra-pyramidal, and cerebellar signs. Tremor and dysarthria are two of the commonest findings. In an earlier paper upon this topic (Crichtley, 1949) three or four commonly recurring syndromes within the punch-drunk state were enumerated. Thus one could isolate a syndrome reminiscent of general paralysis; another which closely resembled disseminated sclerosis; and a third where differentiation was necessary from a frontal lobe tumour. This paper was mainly based upon wartime experience. Since the war one has been impressed with the greater frequency, in civilian practice, of types of punch-drunkenness in which pallid and striatal defects are conspicuous. Here the clinical combination of a mask-like face, slurred monotonous speech, extrapyramidal rigidity, infrequency and slowness of movement, and tremors of the

arms and head constitutes a syndrome which superficially resembles a post-encephalitic Parkinsonian state.

The foregoing constitute the clinical findings in cases of punch-drunkenness. The victim, as a matter of fact, may spontaneously admit to but few disabilities, if any at all. Here, then, is evidence both of the insidious development of the encephalopathy and of the lack of awareness so characteristic of the dementing patient. He may, however, complain of such symptoms as persistent dull headache, postural dizziness, deafness, poor vision, intolerance towards alcohol, unsteady gait, and shakiness. Very occasionally periodic convulsive seizures bring the victim to the doctor. In Service medicine the punch-drunk victim is often identified quite early for other reasons—namely, in his role as a persistent offender. Delinquency therefore may be the evidence of a rapidly changing personality, associated with progressive brain damage.

Illustrative Cases of the Punch-drunk State

The following clinical notes illustrate some of the characteristics of traumatic progressive encephalopathy in boxers.

Case 1: A Punch-drunk Syndrome reminiscent of a Frontal-lobe Tumour.—A professional heavyweight who had been sparring partner to Walter Neusel, Tommy Farr, Eddie Phillips, Max Baer, Jack Hyams, and others gave his story with extreme slowness, and some dysarthria. His actual words were, "I can't think properly and I can't remember things; my speech has been getting bad for 18 months, and for the past two weeks it has been playing hell with me. I can't talk any quicker than I am now. My head goes blank at times. I get pain over my left eye nearly every morning when I wake, but if I rest it goes away, but I feel thick-headed all day long. I get dizzy but I've never lost my senses. The left ear is a bit deaf, and the sight isn't good in the left eye. I can't give my mind to reading; it makes my head worse, I just look at the illustrations."

Case 2: Incipient Punch-drunk Disability in a First-class Heavyweight.—This boxer, who was always liable to headaches after each contest, had found them more persistent in the last few months. It was noticed by others that he was becoming a little slower, and the speech somewhat thick. On the occasion of his last contest he was knocked out, and headaches thereafter became troublesome. Although the patient maintained that he felt well, he was noticeably dysarthric and slow in cerebration. There was a strong suspicion here of an early punch-drunkenness and he was advised to rest. In this view the British Boxing Board of Control concurred, but the U.S. authorities dissented. They insisted on his fulfilling his American contracts, but thereafter he rapidly deteriorated both medically and professionally, and the diagnosis of punch-drunkenness was ultimately agreed upon.

Case 3: Mild Case of Punch-drunkenness with Dementia, Euphoria, and Dysarthria.—This man, aged 61, had fought as a professional lightweight between 1910 and 1926. He became flyweight champion of Essex. Later he went to seed and took on various female boxers, including Madame Carpentier, the world's champion lady boxer. When examined he was complaining of poor powers of concentration and forgetfulness. He would lose the thread in his conversation and had to rely on written memoranda. His mood was extremely euphoric and his speech grossly dysarthric. There was a traumatic arthritis of his thumb-joint with evidence of an old fracture. The E.E.G. was flat. The patient asserted that he would never allow his children to box, and said that "it ought to be stopped."

Case 4: Isolated Convulsive Seizure in a Professional Boxer—? Epilepsy. ? Early Punch-drunkenness.—A man aged 23, who had been a professional lightweight for about four years, had been knocked out only once. Recently, while flying from South Africa, he began to vomit in the aircraft and then lost consciousness and became convulsed. Clinical examination was negative, but the E.E.G. was abnormal, with bilateral synchronous rhythmic slow-wave

discharges suggestive of idiopathic epilepsy. He was advised not to fulfil his engagement to fight the following week ; but this warning was not heeded.

Case 5: Delinquency associated with Early Punch-drunkness.—A naval rating aged 29 was sent to the medical officer with the following report from the regulating petty officer: "He has been adrift for two and a half hours . . . he has lost his respirator in a pub. When spoken to, he belched offensively and without regard. He is a general nuisance, not intelligent, a bad influence. In short, he is evil." When asked what symptoms he complained of, he hooted with laughter and said in a grossly dysarthric fashion, "I've been adrift." Inquiry revealed that he had taken up boxing at 13 and that he had turned professional. He believed he had won about three-quarters of his 300-odd fights. Latterly, after some of his longer fights, he would be groggy and complain of misty vision.

Case 6: Gross Delinquency in a possible mild case of Punch-drunkness.—A featherweight professional boxer aged 27, at one time sparring partner to Seaman Watson, was seen in 1942. In 1937 he had been charged with inflicting grievous bodily harm, but was acquitted. He entered the Service in 1940, and promptly went adrift for 24 hours and then deserted for 14 days. After serving 90 days' detention he almost at once deserted for 21 days. Later he deserted a third time, and was convicted of theft, going to gaol for three months. Thereafter he deserted for seven weeks and married a woman he had met the day previously. He left her immediately after the ceremony and never saw her again. Since then he was charged with a fourth term of desertion. His medical state comprised: headache, poor memory, a tendency towards losing himself in familiar environments, depression, and intolerance towards alcohol.

Case 7: Recurrent Attacks of Hysterical Blindness associated with a Punch-drunk State.—A former bantam-weight champion of Wales and of the West of England aged 27 had been knocked out some 60 times in all. He gave up the ring in 1938 after a fight on account of failing eyesight and hearing. The first attacks of blindness followed a vitriol-throwing incident when he tried to rescue a prostitute from some low joint. He had met her a few days before and had, he thought, persuaded her to go straight, and had given her her fare home. Another attack of blindness took place when he narrowly escaped being run down by a lorry. He suddenly lost his eyesight once again in the naval barracks, and he was examined two weeks later in the R.N. Hospital, Chatham, showing all the dramatic characteristics of a case of hysterical blindness. His vision suddenly returned, but it disappeared once again when he received an anonymous letter impugning the fidelity of his wife.

Case 8: Striatal Type of Punch-drunk Syndrome.—This man, aged 27, began to box at the age of 16 and turned professional. He fought about 200 contests as a bantam-weight, sometimes two or three times a week. Later he appeared in boxing booths, for it was becoming increasingly obvious to him that he was deteriorating. About this time—that is, when aged 27 years—he was rejected at the recruiting office, and he realized then that his sight was poor and that his gait was unsteady. Three months later his hands became tremulous. His symptoms increased up to a point and then remained stationary. On examination he was found to be slightly forgetful. He had a nasal type of dysarthria, his face was expressionless, and he tended to dribble. He had a tremor of the outstretched hands, some increase in muscle tonus, and slight but definite ataxia. Tendon-jerks were increased and there was a right extensor response. The gait was titubant, short-steppage, and stiff.

Case 9: Cerebellar Type of Punch-drunkness, reminiscent of Disseminated Sclerosis.—This man, aged 37, was a professional boxer between the ages of 21 and 31. Successful at first as a lightweight, he deteriorated and took on opponents out of his weight class. He did not think he came to much harm until a particular fight in the Albert Hall when—being distracted by a spectator calling out his name—he was knocked down. He got up after a short count and was floored a second time. This state of affairs

went on again and again, and though he finished the fight he subsequently remembered very little of what happened. His symptoms consisted of progressively increasing tremor and clumsiness of the right upper limb. Examination revealed a slight dysarthria, bilateral intention tremor, increased tendon-jerks, but flexor plantar responses. Appropriate tests brought to light a mild degree of intellectual deterioration.

Case 10: Striato-cerebellar Type of Punch-drunkness.—A professional welterweight, aged 27, whose record had gradually deteriorated, had been knocked out three times. In 1948 (aged 24) after losing his temper with his fiancée, he started to tremble all over. This subsided except in the left hand, where the tremor persisted with increasing amplitude. After six months it involved the head, and his leg began to drag. His articulation altered. Examination revealed a fine tremor of the head, which was held in a curious retracted posture. The speech was dysarthric and staccato. On the left side there was an unusual type of intention tremor, associated with dysdiadochokinesis. The gait showed a steppage abnormality of the left leg. Both plantar responses were extensor in type.

Case 11: Cerebellar Type of Punch-drunkness in an Amateur Boxer.—A man aged 39, who had been four times schoolboy champion of Great Britain, began to develop tremor of the arm during the war, on which account he was invalided from the Army. His symptoms increased slightly and he showed an impassive, rather mask-like face; marked dysarthria; titubation of the head, with some hypertrophy of the muscles of the neck; incoordination of the arms and legs, more so on the left; with intention tremor and dysdiadochokinesis. Originally of superior intelligence, he later showed both an intellectual falling-off and a curious alteration in personality.

Traumatic Encephalopathy

The interval between the onset of a boxing career and the onset of punch-drunk manifestation is often difficult to gauge precisely, but it is usually a matter of years. In an earlier paper (Critchley, 1949) it was stated that in the case of 21 punch-drunk naval patients the interval between the taking-up of a boxing career and the development of neurological symptoms or signs averaged 16 years, with extremes of 6 and 40 years. Of great interest, pathological as well as practical, is the fact that this traumatic encephalopathy is a progressive condition. Once established it not only does not permit of reversibility, but it ordinarily advances steadily. This is the case even though the boxer has retired from the ring and repeated cranial traumata are at an end.

Neurologists have visualized this state of chronic traumatic encephalopathy as being based upon multiple minor cerebral contusions, possibly with initial pinpoint haemorrhages later replaced by a gliosis, cortical atrophy, and internal hydrocephalus. It is a matter of surprise that actual pathological verification should have been so dilatory in its appearance. At the time of the publication of my earlier paper on the punch-drunk syndromes—namely, in 1949—no necropsy material was available. Since that date there has been a report of a single case of punch-drunkness with thorough pathological study (Brandenburg and Hallervorden, 1954). The outstanding findings consisted in a rich profusion of "senile" plaques scattered throughout the shrunken cortex, especially in the frontal lobes. Although the patient was only 51 years of age at the time of death, the histological picture was that of senile dementia, or, alternatively, of an Alzheimer psychosis.

Special *in vivo* investigations of cases of punch-drunkness may indicate the existence of a cerebral atrophy. Air-studies are of particular merit here in that they may demonstrate an atrophic process, especially of the frontal lobes, with corresponding shrinkage of the white matter. Electroencephalography has been widely practised of late in cases of punch-drunkness. The findings have mainly revealed a non-specific type of disordered cortical rhythm, indicative merely of an atrophic process.

This particular method of investigation is of importance in that it might conceivably prove to be a more delicate index of cerebral dysfunction than clinical study. It might lend itself to a screening procedure. By submitting boxers to this test, before a contest and after a contest with or without a knock-out episode, information of value might perhaps be forthcoming. The test could furthermore be applied to experienced pugilists of all types—that is to say, those who proclaim themselves entirely fit and who display no mental or physical deterioration, as well as those who show symptoms or signs of incipient or advanced encephalopathy. A certain amount of electroencephalographic evidence is already to hand.

Although E.E.G.s were carried out on a number of my Royal Naval cases of punch-drunkenness during the war, the literature on this particular topic starts with the paper by Guillain, Sévillano, and Fandré (1948), who observed pathological E.E.G. records in two cases. Thereafter the literature contains many references to electroencephalographic data in boxers. Though of interest, and not without promise of ultimately affording diagnostic assistance, much of the available material is contradictory (Titeca, 1952; Busse and Silverman, 1952; Temmes and Huhmar, 1952; Taylor, 1953; Marquardsen, 1954; Larsson *et al.*, 1954; Kaplan and Browder, 1954; Blonstein and Clarke, 1954; Pampus and Grote, 1956).

From one's personal experience, taken in conjunction with the published evidence, the electroencephalographic aspects of the boxing problem can perhaps be summed up by saying that: (1) minor non-specific anomalies are common in the records of experienced boxers; (2) such findings are commoner and often more intense in cases of punch-drunkenness; but (3) the E.E.G. record is at the present time a less sensitive index of punch-drunkenness than is the clinical evidence, for symptoms and signs may be present at a time when the E.E.G. records are within the limits of normality; and (4) a return to a normal state in a series of E.E.G. records taken in a particular patient cannot be regarded as a *restitutio ad integrum*, whether physiological, anatomical, or clinical.

"Groggy States"

Intermediate between the knock-out (the most acute manifestation of cerebral dysfunction among boxing injuries) and the punch-drunken state (the most chronic among the disorders) is a condition which is referred to in lay terms as the "groggy state." Here, as the result of severe battering sustained during a particular contest, the victim develops a mental confusion with subsequent amnesia, together with an impairment in the speed and accuracy of the motor skill represented by the act of boxing. The affected pugilist may continue to fight, but in an "automatic fashion," to use a lay expression again. The constellation of movements needed for defence and attack takes place at a more inferior level of consciousness, without there being a vigilant awareness of each muscular movement. Unlike many motor skills—for example, driving a car, typing, playing a musical instrument—the motor pattern of a pugilist in the ring depends upon imponderable circumstances—that is, the actions of the opponent. Consequently the movements cannot be carried out with full efficiency unless awareness is intact. Each movement is much more a willed deliberate volitional act than, say, in the case of a skilled typist or pianist, who can go through a set repertory of actions while thinking and talking of something quite different.

In the groggy state this process of active attention is at fault, with resulting falling-off in the quality of performance, more especially in attack.

Even to an unpractised eye it may be obvious that the patient in a groggy state is making feeble and uncoordinated movements, that his limbs are ataxic, and that he is inefficient and vulnerable. He is, as they say, "out on his feet." At this point the referee may stop the fight. The victim may remain indisposed for the next few days, with headaches, postural dizziness, and imbalance. During this time

he may be morose and taciturn, muddled regarding recent events, and perhaps tremulous and dysarthric. This condition passes, and the boxer ordinarily returns to his *status quo ante*. It is arguable, however, that he has suffered a certain cerebral affront, for one groggy state is apt to follow another with succeeding contests. The suggestion, indeed, that an accumulation of groggy states leads to a permanent punch-drunken clinical picture is not to be considered far-fetched. Perhaps, then, we could translate the layman's term "groggy state" into "remitting commotio cerebri."

Illustrative Cases of the Groggy State

The following case notes illustrate the increasing groggy-ness which may follow a particular contest or series of contests.

Case 12.—This man would feel groggy for days after each contest, with his eyesight getting worse temporarily each time. He had particular difficulty in judging distances. This is why he eventually packed up boxing.

Case 13.—"I seemed to go dead, and not to feel the punches. It would now take me two or three days to get over each fight." (Ex-welterweight champion of the West of England.)

Case 14: Latterly he took longer and longer to recover from each fight, because of headaches, defective memory, and impaired speech. His wife did not approve of his boxing and persuaded him to give it up. (Ex-lightweight professional boxer with punch-drunkenness in which headaches and irritability were conspicuous.)

Case 15.—A former welterweight champion of Lincolnshire, aged 30, used to recover from his contests promptly and has even boxed on two consecutive days. Latterly he would remain stiff for some days after each contest. After two years his record deteriorated, especially when he got to London, where he found the style of boxing was different, with more "in-fighting." He stopped boxing for four years, but took it up again when he joined the Navy. In his last contest he went down several times in the fourth round, but he finished the fight "not feeling right" . . . his "limbs felt like rubber" and he complained of a thick head and a sore neck, and he could not sleep. Early morning headaches followed, with severe postural giddiness, irritability, tearfulness, poor memory, fatigue, and lack of interest. Examination brought out that his emotivity and a gross dysarthria were evident.

Case 16.—A man aged 29, never quick on his feet, he could always "take it," and ordinarily "did twelves" (as he put it when questioned on the length of the contests he fought). He packed it up because of his headaches. After one fight he became so unsteady on his legs that he was accused of being drunk. Towards the end of his boxing career he would feel queer for about a week after each fight.

Case 17.—A man aged 28; two weeks before entering hospital he staggered so much in the ring that the audience howled him down and the promoter declared him drunk. In hospital he presented a picture somewhat resembling disseminated sclerosis. Three weeks after his discharge from hospital he fought Paolino in Paris for the heavyweight championship of Europe (this was in 1932), but he was knocked out at the first blow and the crowd stormed the ring.

Case 18.—This man, aged 25, had been four times middleweight champion of Wales and sparring partner to Jack Petersen and to Len Harvey. About six months before coming into hospital he received some blows from Jack Petersen. He had to fight again two days later, but gave up after three rounds because of weakness in his arms. His next fight was a fortnight later; he gave up after the second round because of weakness and tremulousness of his limbs. His manager thought he was drunk. A doctor told him never to box again. He seemed to improve after a month's convalescence in Swansea, but, still being unsteady, he went into the National Hospital, where he was found to be punch-drunken.

Case 19.—A heavyweight aged 31 was knocked out "through the ropes" in 1945 and was dazed for the next 24 hours. The right leg was found to be weak immediately after his fight and continued so. Within the day or two following this same fight his right hand began to shake: the left hand started to tremble some six months later. He was hospitalized seven years later, a typical severe punch-drunk.

Case 20.—A delinquent mild punch-drunk, interviewed in prison, gave up boxing at the age of 20 because he was not feeling himself. He felt drunk although he had taken nothing in the way of alcohol: his head would be in a swim after each fight.

Case 21.—A Royal Navy welterweight, aged 22, matched against a tougher opponent, was struck heavily over the heart in the second round, causing him to feel dizzy or groggy. Shortly after he got a severe blow to the side of the head, flooring him for a count of nine, when he rose and resumed the fight. He could remember vividly every incident up till then; but after that his memory was a blank. Apparently he finished the second round, and in the third round he received heavy punishment, being knocked down 10 times, striking his head on the floor more than once. His next recollection is being on the deck of his ship about an hour later, feeling dizzy and sore about the stomach. Two weeks later he became ill with headaches, vertigo, and vomiting, and was hospitalized. Investigation showed old blood-staining of the C.S.F.

Conclusions

There is much in boxing to interest a practising neurologist, and special attention should be focused upon (1) the phenomenon of groggy states as occurring during or after a contest, and (2) the condition known as traumatic progressive encephalopathy (or punch-drunkness).

Owing to the extreme paucity of pathological data, it is highly desirable that opportunity should be afforded neuropathologists of studying the appearances in the brain of punch-drunk patients.

There is a scope for further study of boxers by electro-encephalographic as well as clinical techniques, at all stages: that is, early as well as late in their careers; and before and immediately after a contest, especially if a knock-out has occurred.

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FURTHER OBSERVATIONS ON THE MEDICAL ASPECTS OF AMATEUR BOXING

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The medical aspects of boxing continue to attract attention in both the medical and the lay press. Recent attacks on the sport (Duggart, 1955; Summerskill, 1956) have aroused further controversy, and the reports of death (Rottgen, 1955; Pampus and Müller, 1956; Müller, 1956) and of possible brain damage (Taylor, 1953; Geller, 1953; La Cava, 1954; Brandenburg and Hallervorden, 1954; Soeder and Arndt, 1954; Pampus and Grote, 1956) repeatedly raise the question of the advisability of allowing youths to indulge in what would appear to be a dangerous and unjustifiable recreation. We therefore thought it worth while to review the boxing injuries, especially those to the head, encountered in the London Amateur Boxing Association contests during the past season, as an extension of a previous report (Blonstein and Clarke, 1954).

Material

During the period of seven months (October, 1955, to April, 1956, inclusive) there were approximately 300 tournaments representing about 3,000 boxing contests under the control of the London Amateur Boxing Association, and these involved almost 5,000 boxers. According to the medical welfare scheme instituted two years ago (Blonstein and Clarke, 1954), all contestants who have been concussed or have suffered lengthy amnesia are rested for at least one month, the exact period depending upon the estimated severity of the injury. It was therefore possible to trace with ease all the boxers who had been knocked out during the season. Those who had been more severely concussed or who had been knocked out more than once were selected for special study. There were 29, and their ages ranged from 17 to 26 years; 23 had been knocked out twice and 6 had been severely concussed on one occasion.

Method

First an attempt was made to classify the boxers according to the severity of their injury, as judged by events in the ring. The following groups could be identified.

Group I: "Out on the Feet."—Following a head blow the boxer was unable to defend himself, was obviously dazed, and staggered about the ring or rested on the ropes.

Group II: Mild Knock-out.—Those who were knocked down and could not rise before the count of 10, but who, although dazed, were not unconscious for more than a few seconds.

Group III: Moderately Severe Knock-out.—Those rendered unconscious, and carried to their corner, where they quickly recovered.

Group IV: Severe Knock-out.—Those remaining unconscious for periods greater than Group III.

This classification accounted for only 26 of the 29 cases, for at times there was a disparity between the observed actions of boxers and the amnesia estimated subsequently.