

My Miracle

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Under the hot Italian Riviera sun in the summer of 1947 the conflict between swimming and watching a motor-bike race in Ospedaletti was a very serious one for Vivian and me. In the event, the motor bike race won. After all, it meant giving up only one of those deliciously lazy days' swimming and snorkling.

The climax of the drama was the astonishing performance of a little scooter – the Vespa – which averaged over 60 m.p.h. over a very exacting mountain course. This performance was sustained for well over an hour. After some 20 minutes of brilliant riding the scooter sustained its only minor fault – the silencer fell off. The loss of the silencer endowed this little machine with a splendidly raucous voice which we could hear around the entire course.

This mechanical incident in the little scooter was in great contrast to other failures which occurred in the more impressive motor bikes in the race; some of them resulted in retirement, and even serious injury. Perhaps I should have taken this as a warning, but a few months later I bought a Vespa (assembled in Bristol, where I live) to reduce my transport costs. Together with the encouragement in Ospedaletti my purchase cost me my life 20 years later. This story could be entitled "I died – but am still alive". This may sound like an indirect claim to divinity but it reflects a serious difficulty: how can I bridge the gap between straightforward personal reminiscence and what I have heard from other people? The trouble is that I was unconscious from June 13 for about 3 weeks and have no memory at all for about 1 week before that – what is called "antrograde amnesia". So for a month in my life I have no memory and during that period, for a few minutes, my breathing and pulse stopped, they tell me. Only by rapid application of the modern techniques did they haul me out of the grave. As a positive and comforting lesson I learned that dying need not be painful. I did not suffer at that time but my loved ones tell me that they were *in extremis* for several weeks. This, too, is a basic fact to bear in mind; the main sufferers in a vital tragedy may be the survivors, not necessarily the casualties.

So, to put what happened in context, I had better outline the events that led up to my accident and the brain injury that was so ironically fascinating for me as a brain scientist when I re-

covered consciousness. Over 20 years ago I got my first motor-scooter, a 125 c.c. two stroke Vespa that had transformed Italian life and thrilled me as a motor bike fan. "Vespa" means "Wasp" in Italian and its voice sounds fierce and effective. The firm of Piaggio in Genova designed and produced the first models because they were not allowed to go on with aircraft manufacture after Italy was defeated in World War II. One of the differences between a scooter and a motor bike is that in the scooter there is no bar between the steering and saddle. The advantage of this is that the rider can slip out of the saddle very easily and I learned to do this in my first years by practice in our garden and on the right-hand bends of the roads (right-hand bends have the unfavourable camber and often a film of oil and grit from passing cars). I fell off my Vespa several times in the first years but never hurt myself badly. I did learn from this and didn't come off at all for about ten years before the final accident of which I remember nothing at all; if there had been a human culprit I would have blamed him but, by another irony, it was a horse that brought about my downfall, or so I am told by my friends and colleagues. I will return to the causal sequence later, as reported to me, but the next experience I can recall for myself was lying in bed in a private room in hospital and gazing at the pale-blue ceiling. To my surprise, there was no element of bewilderment when I opened my eyes there, only a sort of acceptance. I had no idea *why* I was there, no memory of the previous month of crisis and salvation and it was several minutes before I discovered that my left eye was blind, my hair had been shaved off, and the little finger on my right hand was hard to move and tingled all the time. I managed to feel my face and head with my left hand and found a sunken part by my left eye and in patches all over queer, false, prickly feelings. The top of my head was numb all over; when I tapped it, I could hear the sound but not feel it at all. At that time I had been working with brain surgeons for 35 years and soon realised that I had had a brain operation and must be in Frenchay Hospital. But why? I began to feel over my body and found I had scabs over wounds on both my elbows and both my knees. This seemed very odd indeed at the time and I sat up to try and look at my knees. This effort elicited another sign of illness - sitting up made me feel terribly giddy and I had to lie back on the bed. For several days I couldn't stand at all and had to use a bottle to empty my bladder several times a day. I noticed that I produced more than a litre every day and nearly as much in the night. After the overpowering giddiness,

this polyuria was the second functional oddity I noticed, and now, four months later, it's the same, with "polydipsia" – drinking more than usual – as well. Then, still on my first morning of consciousness, I noticed by touch an open scar on my throat which puzzled me. It was horizontal and a little damp, between the rings of cartilage on my trachea. I uttered a few words of wonder and found my voice was odd – sort of flat and monotonous. Just then a ward Sister came in to take my temperature and then proffered a cup of tea which I welcomed. To my astonishment I couldn't taste it at all except for the sweetness of the sugar and never since have I had any real taste for food and drink except the tongue tastes of salt, sour, bitter and sweet. During the previous winter I had resolved to eat less and give up smoking so my loss of taste, or rather smell, fitted in quite well with my reformation. It was an odd feeling later on, when I managed to get home, to see someone smoking and not be able to smell the smoke at all; it made me resigned to the deficiency and ultimately to feel rather superior. I did try a few cigarettes from time to time and confirmed that they did nothing for me at all – I couldn't tell that I was smoking even when I inhaled. There were notices "You have been asked *not* to smoke" in all the hospital wards and rooms and I felt quite virtuous not having to make an effort to comply. I was told I had lost nearly 15 pounds of body-weight since the accident and when ultimately I was able to see my body in a looking glass I saw I had regained a waist-line, but my thighs had shrunk to the bone. I started to do some rather furtive exercises in bed, which must have looked quite erotic when the nursing sisters peeked in through the observation slot. Actually, this was one of the feelings that had faded – sex was only a word and not a passion to me for some months after. It was a strange experience to lie in bed for weeks, feeling better and more active every day, yet realising that what had been the great emotional force had somehow faded away since my brain had been bruised. This was a disturbing feature but not my principal worry; I doubted whether I could ever do my scientific job again and whether I would ever be entitled to draw my generous salary in future. I should explain that when our Institute started to subscribe to a superannuation scheme my pay was too low and my scale of living too high for me to afford to contribute, so, in effect, I had no prospect of a pension from the Institute. This meant that, should I fail in my job, my income would cease and I would have to accept the rigours of extreme poverty. I was 60 years old at the time of the accident, so the senile crisis was not so far off, and I felt

that my colleagues – who are all friends too – could explain my decline by advanced age, which they could forgive and mitigate with sympathy. The snag – in my imagination at least – was that an ageing scientist does not recover from his ailment, whereas some brains do recover from a concussion, and I tried to plan a way to persuade them that I was a convalescent patient rather than a presenile dementia.

That first morning that I remember after the accident I had several visitors, more welcome to me than the nursing staff, but not more skilful or attentive. They included the surgeons who had operated on my head, my friends and my son Timothy, and a selection of the others at the Institute. All these were in effect my saviours and, little by little, I gathered how terribly they had suffered in the last weeks. I feel impelled to say here that I acknowledge with pride and humility the enormous debt that I owe them – no less than life itself and the happiness that is beginning to lighten the horizon. Perhaps I should add that my anxiety included a special worry about my son Timothy, who was about to start his third year at Cambridge University. At the start of his first year his mother and I had discovered that he had the ghastly disease of muscular dystrophy, so my worry was about clinical and financial facts, not fantasies.

Actually, I did indulge in fantasy in the first few days I can remember. I could not account for the traces of my injuries and invoked three quite ludicrous dream-like visions which I elaborated as I lay on my back, in the intervals between visits. All these waking dreams attributed my troubles to my surgeon friends – quite falsely of course – and when I mentioned them the alleged culprits laughed out loud. The first fantasy was to account for the physical fact that two of my lower front teeth had disappeared; I had had a dream weeks before when we were preparing for a holiday that a friend and pupil of mine, Victor Rothschild (now Lord Rothschild) and his sister Miriam were running a travel agency and had sent us two slides, both picturing the inside of a mouth seen from the front. In one Victor was grinning from the back through the molar teeth with an Italian mountain on his shoulder. In the other slide Miriam was flashing her brown eyes through a gap between the front teeth and was nodding her head provocatively. I had not been surprised or puzzled at the inclusion of movement in a slide but I was convinced that the surgeons had operated on my jaw and teeth to provide just the oral landscape that the Rothschilds wanted for their non-existent travel agency. The other fantasy was to account

for the scars on my knees and elbows. These were nearly healed and I supposed that the surgeons had taken off my limbs and attached them to an American pilot who wanted to be flown cheaply to Australia. With my limbs on he had got into a small box and been sent to the other side of the world with a bit of space between his body and the box. He had rattled around a bit and borne the bruises on my projecting joints. The lack of incision scars at my hips and shoulders aroused my astonished admiration and it was this negative trace that I mentioned to the surgeons and that was what evoked their amusement and my enlightenment. The third systematic fantasy was about the changes in my head, including the blindness of my left eye. It suddenly occurred to me that the surgeons must have turned my head right round, dressed the hair at the back of my head to form a beard but somehow missed the connection of my left eye with the optic nerve. This, too, is quite absurd and impossible, but I told the surgeons and again they dismissed it with ridicule. My silly, elaborate fictions persuaded them to tell me some of the facts about the accident and operation. The operation was nearly 2 weeks after the accident because, they said, I was unconscious and otherwise too ill for head surgery, and in any case they couldn't decide what they should do. The operation lasted about 5 hours and included a detailed recording of the electrical activities all over the brain - "electro-corticography". This showed some peculiarities in various parts but nothing really sinister and they were able to sew up a tear in the membrane that was allowing brain fluid to leak down into my brain-stem. They thought it was this leak that had "killed" me and caused the other crises from which they and the nursing staff had extricated me. This seemed to make sense, although it didn't explain precisely why I had lost the sight of my left eye and the two lower front teeth. However it did account for my dizziness and loss of balance-sense when I sat up.

From that phase on I decided to make a resolute effort to re-establish my personality with the originality and creativity which had been, I supposed, my main contribution to the Institute brain-research. This decision was quite easy to make, since the alternative was resignation to my disability and from my position at the Institute. This latter seemed to me a sort of tragic legacy to my son Tim: why should he be made to suffer more from my accident? So I was determined to accept the responsibility of promoting and accelerating my recovery; not just recovery to my state a few months before, but recovery in such a way as to encourage my development to a few months in the future. My talks with the

people at the Institute had included their news and it was evident that research had been advancing rapidly on several fronts during my illness. It wouldn't be much good my going *back* 6 months; I must use my 6 months-ago-state as a spring board to project me ahead, hand in hand with my colleagues. The decision was easy but the act was devious and difficult. I had not been particularly introspective and so the first problem was to analyse myself so that I could specify the restoration in detail. This is not easy, especially when one's brain has been hurt and the destiny of oneself and one's family depends on it. I have got used to it now, but I still make mistakes and come up against apparently insoluble paradoxes. But I now do realise some of the basic complexities of human personality and the amount we still have to discover about how the brain works and how damage to it can be diagnosed and treated. I thought to myself that what I had determined to do was a part of my professional concern and that concept doubled my satisfaction with the prospect.

My first challenge was the physical state of my body. I couldn't look forward to a return to my full contribution if I were going to be a thinking vegetable – I must learn to stand and walk and talk and write and calculate and write programs for our computers and design experiments and . . . and . . . *THINK*. How did I think? Thinking involved "association", "integration", imagination, conceptualisation, generalisation, abstraction – how does one think about thinking? How much of thinking is verbalisation?

While these doubts and questions were floating through my clumsy consciousness, various visitors came, bearing gifts of papers, books, sweets, flowers, drinks and, most important and indispensable to me, love. The gifts were welcome, of course, in my spartan side-room, but their effect was to act as reminders of the feeling that had brought the givers. In those days I used to gaze at any modest present and recapture more readily the feeling that had grown so big for my loved ones. Sometimes I felt a tear trickle down my cheek. I thought at first it was a sensation due to my brain injury, but it was wet and a little salty so that I could acknowledge my sentiment as deep and pure.

When Vivian and Tim came I was enormously relieved because they looked quite well and chatted happily. The first time, I was still bed-fast but after 10 days or so I had begun to stagger around and we went for a short walk outside; we were able to see Vivian's new car, an orange sports coupé, from a distance. This re-opened the possibility of travel, which I had not envisaged. From then on

my thinking roamed and I got stuck on two ideas – to get home and to visit Italy.

About two weeks after my return to consciousness my friends told me they had arranged to take me for a drive in the country that afternoon. So I put on a jersey and a pair of trousers and walked slowly out to the car. It was the new one we had got for Tim, with plenty of room and power. That drive was my first real thrill after the accident; comfort, movement, change, love, company, all the factors one longs for and seldom finds all together. Tim came with us and we chatted intimately about the countryside and the car and I spoke a little too about my wounds and welfare. I was quite glad to get back to the hospital because I was a little tired after my first expedition. The country around Bristol is a grand place to drive through and my mental vision was full of the landscapes. It was a glorious experience to renew my knowledge of our physical world in that way and I felt no nervousness or fear at being on the road again. My amnesia for the accident was a sign of Nature's mercy to the afflicted: you can't be scared of what you don't remember.

Our next adventure was to visit my home again – but it was a little more complicated. For one thing my home is something special, a fine, detached house that I had had built in 1939, with a nice grassy garden, roses, two cars, five bedrooms, colour TV, central heating, and for me it was the image and symbol of normal practical creativity and convenience. I had also cultivated in hospital a dream of washing my hair with my favourite shampoo in our bathroom upstairs in our home. I had been given a bath every other day in hospital and washed my short but growing hair with the medicinal soap, but my head seemed to itch or tickle at night and I had conceived the notion that a special shampoo would be a relief. I think the irritation was where my skin was healing after the operation, but I became obsessed with the need to scrub it. The drive home was another thrill – 15 minutes of suburban avenues leading to our flat-roofed tawny-brick mansion and the armchairs on the patio overlooking the lawn. The sun shone brilliantly and we sat chatting and laughing. I was talking less than the others, thinking of my hair-washing project and rather abruptly I said I was going upstairs to do it. There was instant consternation and protest; we had been warned that I might have trouble going upstairs and could come down backwards, not having had to deal with a step since the crash. My companions had decided not to allow or approve my adventure and were horrified that I had planned it. All three objected fluently but I rose and went jerkily through to the staircase

and started to climb it. This was a little tricky and I had to hold on with my hands, but I got up all right with the others muttering and gasping close behind me. In the bathroom I managed to undress quite quickly, turned on the taps and got into the bath by holding my body up on my hands and lifting one leg after another into the tub. I could only just raise my feet high enough, and sank into the bath with relief. Sure enough, the special shampoo was there and I had the reward of a splendid two-stage hair wash. I couldn't smell the piney odour of the liquid but it looked and felt just right. When I had finished I extricated myself with the others' help and they insisted that I retire to our bed to rest from my exertions. They told me I lay there grinning like a Cheshire cat for half an hour, delighted with my achievement. To be in my own house, wash my own hair, view my own garden with my dear ones, was a unique experience, so reassuring of homeliness, security, stability, and, most important, love, that I felt from then on that I could and would recover my mentality and personality that those others had loved, and that I could return to work before too long with confidence and ample means to contribute and share with my professional friends. Perhaps my determination to shampoo was a bit too much on that first home visit but it turned out well and was an example of what I had decided I should do - to plan every day an exercise that was something new to do, but possible. The first one had been just walking a few steps, then standing on one leg and now I can do this with my eyes shut, but I had to practise every movement and re-learn actions that had been automatic for over half a century. It was a sobering shock to have to start from square one again, but also it was a revelation to have to analyse and resynthesise such simple acts. One can regain in this way the original novelty and excitement that energize living for children - to an adult the needs may be familiar enough, but the means to satisfy them have to be learned again and this can be fun. When I got up we drove quietly back to the hospital and it was quite a relief to return to the skilful care of the nursing staff; they had been so gentle, tactful and resourceful that I had the feeling that all my wants were anticipated and satisfied. This was a new and thrilling experience also; one that I hope all patients can share, even those that are as ill as I was. It may have something in common with the relief and courage that some people say they get from religious faith - a belief that there is divinity even in the most painful circumstances.

While I was in hospital my close colleague, Dr. Cheyne McCallum, had twice studied my electric brain activity, using the elaborate

recording and computing instruments we had installed in our new laboratory at Frenchay. This was next door to the ward I was in and I managed to walk there to lie on the couch. Our new methods include the analysis of brain changes during learning and we discovered a new sort of electric wave that develops always and only when a person learns a new task. The long name for this is the Contingent Negative Variation (or CNV), but it is also known as the Expectancy Wave because its appearance means that the person is expecting one event to follow another. The CNV is also related to motivation, conation, association, decision, discrimination and in fact most of the concepts that are involved in learning. We have found that in people with injured brains the CNV may be absent in parts of the brain that look normal otherwise. This means that high-level activity such as learning may not be possible for parts of the brain that are still alive and this subtle disability may account for the very long time – 10 years or so – over which brain injuries may seem to recover. We think a detailed study of the distribution of the CNV over the head can be a great help in finding out how much a damaged brain can do and also in advising friends and relatives how they can help the patient to recover his character. This task is very difficult because the CNV is very small – only about 20 millionths of a volt – and to determine its distribution over the head a computer has to be carefully programmed to display an electric map automatically time after time. We have two computers now, thanks to the insight and generosity of the Stone Foundation of Chicago, and both are used full-time to study and chart the CNV, so Cheyne had no difficulty in getting a clear set of charts and he and I were surprised and relieved to find there was nothing radically wrong with my CNV. At that time I was getting pretty active mentally, reflecting for long periods on how I could best regain my capacity and overcome my residual disabilities. I was still worried that I might find it hard to establish the originality and imagination that had been an important part of my contribution to brain research at the Institute. I had studied hundreds of cases of brain injury during the previous thirty years and followed their recovery. Many who had been as seriously hurt as I had been did recover physical health, but very few had regained posts of leadership and responsibility. It seemed likely that top jobs need just about all the brain, at any rate from time to time, and if a patient had to re-learn simple childish acts like walking, this may need brain parts that had previously been free for higher-level thinking. This proposition may lead to exciting new research, and our ignorance

of how the brain really works at top level was what I stumbled over at every turn of thought. During my first brain recording Cheyne noticed something that looked like an alpha rhythm in my brain records and was astonished because on the numerous occasions of my previous recordings I had never produced a single alpha wave. Long before we had been struck by the fact that about 15 out of 100 people have no alpha rhythm and we had found that these people were limited to visual imagery in their thinking. I am a marked visualist myself, and the appearance of an alpha rhythm after my brain injury suggested that it may have altered my personality. When we first discussed this I recalled that around the period of my alpha rhythm my mind seemed capable of "free-wheeling" - feeling blank but healthy, which was a novel experience for me. Later, my visual images began to return obtrusively and now I feel quite like I remember feeling before the injury. This is another effect that might be worth investigation: a significant brain abnormality may turn out to be the appearance of a new feature which would be quite normal for another person. The fine structure of personality still eludes us, and it may well be that we shall have to include elaborate studies of the chemistry of brain cells as well as their electric patterns in order to recognise the basis of a person's character.

Cheyne repeated the examination some days later and confirmed the health and normality of my brain waves. I enjoyed being a subject for the elaborate studies since I had to press a button as quickly as I could to stop a series of light-flashes, and there was always a click as a warning before the lights appeared. The situation is intended to test the ability and speed of the brain in learning the association between the signals and making the hand muscles respond as fast and economically as possible. It was a great comfort to have the objective confirmation of my recovery, particularly since I had discovered this effect myself five years before in a survey of autistic and normal children. One of the most dramatic services of scientists to medicine has been in the management of sick children who cannot co-operate because of their disability. The dilemma in the case of autistic children is that their failure to respond or interact with others may be due to an incompetence of their brains, or, the other way round, the lack of signs of high level brain activity may be due to their lack of interest in others. The causal relations between signs and symptoms is often hard to establish, particularly when the brain is involved. The many parts of the brain are interconnected in loops, and in such a complex of feed-back systems any

interference may have a dramatic effect without reaching a significant causal agent. That is one of the reasons why social psychology and brain physiology are so hard to fit together; there is no doubt that behaviour patterns emanate from the brain, but no two brains are alike and the differences between them are seen in the rapture and catastrophe of social dynamics. As a brain scientist, I found myself gradually more and more enmeshed in such problems, which had been the target of our Institute since its foundation in 1939. That I was fascinated by them suggested that I was regaining my original mentality but my remaining difficulty in finding an easy way to solutions alarmed me – I couldn't at that time see my way to cultivate creativity. So I decided to make myself accessible to my professional friends so that they could confide in me and share their dreams as well as their problems. That is what I enjoy most and I don't think of it as "work", although it needs training and practice like an elaborate game or sport. My attitude is by no means casual or frivolous, however. My "work" is a large part of my whole life and has been for over 40 years since I graduated at Cambridge. My experience of what is now called "electronics" is even longer – over 50 years since my father and I started to make "wireless" sets in 1919, before there was any broadcasting in Britain. This familiarity with electricity was a very lucky accident since the study of brain dynamics started as a combination of electro-technology and physiology. I was able to design and build my first amplifiers and oscillographs and with them I was able to locate the brain tumour in the first patient referred to me in 1935. So it was not only novel but ironical to become a patient myself after a lifetime studying others, and the outcome was all the more reassuring because I had been the one to develop and apply the methods that were being used. Of course, there are many other people involved in the same sort of study and the most satisfying feature of the special brain research societies is the warmth of friendship between the members. This does not impinge on the privacy of separate people but unites them in excitement and mutual esteem.

These were the thoughts that permeated my mind in the days I can remember in hospital and from them emerged my determination to return to brain research with the enrichment of my nearly fatal experience. The daily events in the hospital were the frequent little meals brought by the nurses, my tottering steps to the bathroom and lavatory and the exciting visits of my dear colleagues and relatives. As well as the nearby sympathisers, I was shown a sheaf of letters and cables from friends all over the world who expressed

in simple words what I had hoped and assumed, that they were almost lost in misery, but clinging to a shred of hope. The devoted visits and the affectionate messages were my path back to health and vigour. I learned that what I can remember is only a part of the service done me. I have a feeling that the strange state I was in for so long – apparently responding but not “conscious” – did not efface, but rather transferred my appreciation of what was done, so that when I did regain full consciousness, my recovery was directed to a high but attainable level, guided by the impalpable traces of early experience.

The definition of consciousness is vague and confusing; so many patients display long phases of responsiveness and may carry on quite long, and apparently reasonable and coherent, conversations soon after an operation, yet have no memory of that experience the day after. The anomaly is only noticed when the two days are compared. Both separately would be judged normal but together they reveal a gross but inexplicable abnormality. The brain mechanisms underlying memory are still obscure and we are not certain whether the notion of different grades or levels is realistic and helpful. For patients in such conditions it would be kind to assume the presence of some sort of awareness unless they are in a deep coma without a sign of response in brain or body. When an electric sign of brain response can be detected, there is objective evidence for hope of recovery provided that some sort of stimulating conditions can be maintained. This is a challenge to everyone connected with the patient, particularly those who know him well. In the absence of specific knowledge we have to depend on trial and reversible error, assuming that the criteria of health and recovery are clear and well known.

Now that I can look back and appreciate the grim situation I was in for so long, the suffering and effort of my dear and close friends seems the crucial factor that triggered my resolve to recover. I wanted to be worthy of their devotion, not merely to be able to regain my position at the Institute. The gruesome experience of my professional colleagues depressed and discouraged them in the first days after the accident. As it turned out, their hope was justified, but in those first days, of which I have no trace of memory, their fortitude must have needed cool imagination as well as warm affection.

Whatever the source of my friends' engagement with my condition, it reinforced my determination to regain my energy and concentration, of which the first sign was this writing, a prelude to the re-establishment of my full function in the Institute.