The Story of a Brain[1]

by Arnold Zuboff

I

Once upon a time, a kind young man who enjoyed many friends and great wealth learned that a horrible rot was overtaking all of his body but his nervous system. He loved life; he loved having experiences. Therefore he was intensely interested when scientist friends of amazing abilities proposed the following:

'We shall take the brain from your poor rotting body and keep it healthy in a special nutrient bath. We shall have it connected to a machine that is capable of inducing in it any pattern at all of neural firings and is therein capable of bringing about for you any sort of total experience that it is possible for the activity of your nervous system to cause or to be.'

The reason for this last disjunction of the verbs 'to cause' and 'to be' was that, although all these scientists were convinced of a general theory that they called 'the neural theory of experience,' they disagreed on the specific formulation of this theory. They all knew of countless instances in which it was just obvious that the state of the brain, the pattern of its activity, somehow had made for a man's experiencing this rather than that. It seemed reasonable to them all that ultimately what decisively controlled any particular experience of a man--controlled whether it existed and what it was like--was the state of his nervous system and more specifically that of those areas of the brain that careful research had discovered to be involved in the various aspects of consciousness. This conviction was what had prompted their proposal to their young friend.

That they disagreed about whether an experience simply consisted in or else was caused by neural activity was irrelevant to their belief that as long as their friend's brain was alive and functioning under their control, they could keep him having his beloved experience indefinitely, just as though he were walking about and getting himself into the various situations that would in a more natural way have stimulated each of those patterns of neural firings that they would bring about artificially. If he were actually to have gazed through a hole in a snow-covered frozen pond, for instance, the physical reality there would have caused him to experience what Thoreau described: 'the quiet parlour of the fishes, pervaded by a softened light as through a window of ground glass, with its bright sanded floor the same as in summer.' The brain lying in its bath, stripped of its body and far from the pond, if it were made to behave precisely as it naturally would under such pond-hole circumstances, would have for the young man that very same experience.

Well, the young man agreed with the concept and looked forward to its execution. And a mere month after he had first heard the thing proposed to him, his brain was floating in the warm nutrient bath. His scientist friends kept busy researching, by means of paid subjects,

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which patterns of neuron firings were like the natural neural responses to very pleasant situations; and, through the use of a complex electrode machine, they kept inducing only these neural activities in their dear friend's brain.

Then there was trouble. One night the watchman had been drinking, and, tipsily wandering into the room where the bath lay, he careened forward so his right arm entered the bath and actually split the poor brain into its two hemispheres.

The brain's scientist friends were very upset the next morning. They had been all ready to feed into the brain a marvellous new batch of experiences whose neural patterns they had just recently discovered.

‘If we let our friend's brain mend after bringing the parted hemispheres together,’ said Fred, ‘we must wait a good two months before it will be healed well enough so that we can get the fun of feeding him these new experiences. Of course, he won't know about the waiting; but we sure will! And unfortunately, as we all know, two separated halves of a brain can't entertain the same neural patterns that they can when they're together. For all those impulses which cross from one hemisphere to another during a whole-brain experience just can't make it across the gap that has been opened between them.’

The end of this speech gave someone else an idea. Why not do the following? Develop tiny electrochemical wires whose ends could be fitted to the synapses of neurons to receive or discharge their neural impulses. These wires could then be strung from each neuron whose connection had been broken in the split to that neuron of the other hemisphere to which it had formerly been connected. ‘In this way,’ finished Bert, the proposer of this idea, ‘all those impulses that were supposed to cross over from one hemisphere to the other could do just that-carried over the wires.’

This suggestion was greeted with enthusiasm, since the construction of the wire system, it was felt, could easily be completed within a week. But one grave fellow named Cassander had worries. ‘We all agree that our friend has been having the experiences we've tried to give him. That is, we all accept in some form or other the neural theory of experience. Now, according to this theory as we all accept it, it is quite permissible to alter as one likes the context of a functioning brain, just so long as one maintains the pattern of its activity. We might look at what we're saying this way. There are various conditions that make for the usual having of an experience—an experience, for instance, like that pond-hole experience we believe we gave our friend three weeks ago. Usually these conditions are the brain being in an actual body on an actual pond stimulated to such neural activity as we did indeed give our friend. We gave our friend the neural activity without those other conditions of its context because our friend has no body and because we believe that what is essential and decisive for the existence and character of an experience anyway is not such context but rather only the neural activity that it can stimulate. The contextual conditions, we believe, are truly inessential to the bare fact of a man having an experience—even if they are essential conditions in the normal having of that experience. If one has the wherewithal, as we do, to

get around the normal necessity of these external conditions of an experience of a pond hole, then such conditions are no longer necessary. And this demonstrates that within our concept of experience they never were necessary in principle to the bare fact of having the experience.

‘Now, what you men are proposing to do with these wires amounts to regarding as inessential just one more normal condition of our friend's having his experience. That is, you are saying something like what I just said about the context of neural activity—but you're saying it about the condition of the proximity of the hemispheres of the brain to one another. You're saying that the two hemispheres being attached to one another in the whole-brain experiences may be necessary to the coming about of those experiences in the usual case, but if one can get around a breach of this proximity in some, indeed, unusual case, as you fellows would with your wires, there'd still be brought about just the same bare fact of the same experience being had! You're saying that proximity isn't a necessary condition to this bare fact of an experience. But isn't it possible that even reproducing precisely the whole-brain neural patterns in a sundered brain would, to the contrary, not constitute the bringing about of the whole-brain experience? Couldn't proximity be not just something to get around in creating a particular whole-brain experience but somehow an absolute condition and principle of the having of a whole-brain experience?’

Cassander got little sympathy for his worries. Typical replies ran something like this: ‘Would the damn hemispheres know they were connected by wires instead of attached in the usual way? That is, would the fact get encoded in any of the brain structures responsible for speech, thought or any other feature of awareness? How could this fact about how his brain looks to external observers concern our dear friend in his pleasures at all—any more than being a naked brain sitting in a warm nutrient bath does? As long as the neural activity in the hemispheres— together or apart—matches precisely that which would have been the activity in the hemispheres lumped together in the head of a person walking around having fun, then the person himself is having that fun. Why, if we hooked up a mouth to these brain parts, he'd be telling us through it about his fun.’ In reply to such answers, which were getting shorter and angrier, Cassander could only mutter about the possible disruption of some experiential field ‘or some such.’

But after the men had been working on the wires for a while someone else came up with an objection to their project that did stop them. He pointed out that it took practically no time for an impulse from one hemisphere to enter into the other when a brain was together and functioning normally. But the travel of these impulses over wires must impose a tiny increase on the time taken in such crossovers. Since the impulses in the rest of the brain in each hemisphere would be taking their normal time, wouldn't the overall pattern get garbled, operating as if there were a slowdown in only one region? Certainly it would be impossible to get precisely the normal sort of pattern going—you'd have something strange, disturbed.

When this successful objection was raised, a man with very little training in physics suggested that somehow the wire be replaced by radio signals. This could be done by outfitting the raw face—of the split—of each hemisphere with an ‘impulse cartridge’ that

would be capable of sending any pattern of impulses into the hitherto exposed and unconnected neurons of that hemisphere, as well as of receiving from those neurons any pattern of impulses that that hemisphere might be trying to communicate to the other hemisphere. Then each cartridge could be plugged into a special radio transmitter and receiver. When a cartridge received an impulse from a neuron in one hemisphere intended for a neuron of the other, the impulse could then be radioed over and properly administered by the other cartridge. The fellow who suggested this even mused that then each half of the brain could be kept in a separate bath and yet the whole still be engaged in a single whole-brain experience.

The advantage of this system over the wires, this fellow thought, resided in the 'fact' that radio waves take no time, unlike impulses in wires, to travel from one place to another. He was quickly disabused of this idea. No, the radio system still suffered from the time-gap obstacle.

But all this talk of impulse cartridges inspired Bert. 'Look, we could feed each impulse cartridge with the same pattern of impulses it would have been receiving by radio but do so by such a method as to require no radio or wire transmission. All we need do is fix to each cartridge not a radio transmitter and receiver but an "impulse programmer", the sort of gadget that would play through whatever program of impulses you have previously given it. The great thing about this is that there is no longer any need for the impulse pattern going into one hemisphere to be actually caused, in part, by the pattern coming from the other. Therefore there need not be any wait for the transmission. The programmed cartridges can be so correlated with the rest of our stimulation of neural patterns that all of the timing can be just as it would have been if the hemispheres were together. And, yes, then it will be easy to fix each hemisphere in a separate bath—perhaps one in the laboratory here and one in the laboratory across town, so that we may employ the facilities of each laboratory in working with merely half a brain. This will make everything easier. And we can then bring in more people; there are many who've been bothering us to let them join our project.'

But now Cassander was even more worried. 'We have already disregarded the condition of proximity. Now we are about to abandon yet another condition of usual experience—that of actual causal connection. Granted you can be clever enough to get around what is usually quite necessary to an experience coming about. So now, with your programming, it will no longer be necessary for impulses in one half of the brain actually to be a cause of the completion of the whole-brain pattern in the other hemisphere in order for the whole-brain pattern to come about. But is the result still the bare fact of the whole-brain experience or have you, in removing this condition, removed an absolute principle of, an essential condition for, a whole-brain experience really being had?'

The answers to this were much as they had been to the other. How did the neural activity know whether a radio-controlled or programmed impulse cartridge fed it? How could this fact, so totally external to them, register with the neural structures underlying thought, speech, and every other item of awareness? Certainly it could not register mechanically.

Wasn't the result then precisely the same with tape as with wire except that now the time-gap problem had been overcome? And wouldn't a properly hooked-up mouth even report the experiences as nicely after the taped as after the wired assistance with crossing impulses?

The next innovation came soon enough—when the question was raised about whether it was at all important, since each hemisphere was now working separately, to synchronize the two causally unconnected playings of the impulse patterns of the hemispheres. Now that each hemisphere would in effect receive all the impulses that in a given experience it would have received from the other hemisphere—and receive them in such a way as would work perfectly with the timing of the rest of its impulses—and since this fine effect could be achieved in either hemisphere quite independent of its having yet been achieved in the other, there seemed no reason for retaining what Cassander sadly pointed to as the 'condition of synchronization.' Men were heard to say, 'How does either hemisphere know, how could it register when the other goes off, in the time of the external observer, anyway? For each hemisphere what more can we say than that it is just precisely as if the other had gone off with it the right way? What is there to worry about if at one lab they run through one half of a pattern one day and at the other lab they supply the other hemisphere with its half of the pattern another day? The pattern gets run through fine. The experience comes about. With the brain parts hooked up properly to a mouth, our friend could even report his experience.'

There was also some discussion about whether to maintain what Cassander called 'topology'—that is, whether to keep the two hemispheres in the general spatial relation of facing each other. Here too Cassander's warnings were ignored.

II

Ten centuries later the famous project was still engrossing men. But men now filled the galaxy and their technology was tremendous. Among them were billions who wanted the thrill and responsibility of participating in the 'Great Experience Feed.' Of course, behind this desire lay the continuing belief that what men were doing in programming impulses still amounted to making a man have all sorts of experiences.

But in order to accommodate all those who now wished to participate in the project, what Cassander had called the 'conditions' of the experiencing had, to the superficial glance, changed enormously. (Actually, they were in a sense more conservative than they had been when we last saw them, because, as I shall explain later, something like 'synchronization' had been restored.) Just as earlier each hemisphere of the brain had rested in its bath, now each individual neuron rested in one of its own. Since there were billions of neurons, each of the billions of men could involve himself with the proud task of manning a neuron bath.

To understand this situation properly, one must go back again ten centuries, to what had occurred as more and more men had expressed a desire for a part of the project. First it was agreed that if a whole-brain experience could come about with the brain split and yet the two

halves programmed as I have described, the same experience could come about if each hemisphere too were carefully divided and each piece treated just as each of the two hemispheres had been. Thus each of four pieces of brain could now be given not only its own bath but a whole lab—allowing many more people to participate. There naturally seemed nothing to stop further and further divisions of the thing, until finally, ten centuries later, there was this situation—a man on each neuron, each man responsible for an impulse cartridge that was fixed to both ends of that neuron—transmitting and receiving an impulse whenever it was programmed to do so.

Meanwhile there had been other Cassanders. After a while none of these suggested keeping the condition of proximity, since this would have so infuriated all his fellows who desired to have a piece of the brain. But it was pointed out by such Cassanders that the original topology of the brain, that is, the relative position and directional attitude of each neuron, could be maintained even while the brain was spread apart; and also it was urged by them that the neurons continue to be programmed to fire with the same chronology—the same temporal pattern—that their firings would have displayed when together in the brain.

But the suggestion about topology always brought a derisive response. A sample: 'How should each of the neurons know, how should it register on a single neuron, where it is in relation to the others? In the usual case of an experience it is indeed necessary for the neurons, in order at all to get firing in that pattern that is or causes the experience, to be next to each other, actually causing the firing of one another, in a certain spatial relation to one another—but the original necessity of all these conditions is overcome by our techniques. For example, they are not necessary to the bare fact of the coming about of the experience that we are now causing to be had by the ancient gentleman whose neuron this is before me. And if we should bring these neurons together into a hook-up with a mouth, then he would tell you of the experience personally.'

Now as for the second part of the Cassanders suggestion, the reader might suppose that after each successive partitioning of the brain, synchronization of the parts would have been consistently disregarded, so that eventually it would have been thought not to matter when each individual neuron was to be fired in relation to the firings of the other neurons just as earlier the condition had been disregarded when there were only two hemispheres to be fired. But somehow, perhaps because disregarding the timing and order of individual neuron firings would have reduced the art of programming to absurdity, the condition of order and timing had crept back, but without the Cassanderish reflectiveness. 'Right' temporal order of firings is now merely assumed as somehow essential to bringing about a given experience by all those men standing before their baths and waiting for each properly programmed impulse to come to its neuron.

But now, ten centuries after the great project's birth, the world of these smug billions was about to explode. Two thinkers were responsible.

One of these, named Spoilar, had noticed one day that the neuron in his charge was getting a bit the worse for wear. Like any other man with a neuron in that state, he merely obtained another fresh one just like it and so replaced the particular one that had got worn—tossing the old one away. Thus he, like all the others, had violated the Cassanderish condition of 'neural identity'—a condition never taken very seriously even by Cassanders. It was realized that in the case of an ordinary brain the cellular metabolism was always replacing all the particular matter of any neuron with other particular matter, forming precisely the same kind of neuron. What this man had done was really no more than a speeding up of this process. Besides, what if, as some Cassanders had implausibly argued, replacing one neuron by another just like it somehow resulted, when it was eventually done to all the neurons, in a new identity for the experiencer? There still would be an experiencer having the same experience every time the same patterns of firings were realized (and what it would mean to say he was a different experiencer was not clear at all, even to the Cassanders). So any shift in neural identity did not seem destructive of the fact of an experience coming about.

This fellow Spoilar, after he had replaced the neuron, resumed his waiting to watch his own neuron fire as part of an experience scheduled several hours later. Suddenly he heard a great crash and a great curse. Some fool had fallen against another man's bath, and it had broken totally on the floor when it fell. Well, this man whose bath had fallen would just have to miss out on any experiences his neuron was to have been part of until the bath and neuron could be replaced. And Spoilar knew that the poor man had had one coming up soon.

The fellow whose bath had just broken walked up to Spoilar. He said 'Look, I've done favors for you. I'm going to have to miss the impulse coming up in five minutes—that experience will have to manage with one fewer neuron firing. But maybe you'd let me man yours coming up later. I just hate to miss all the thrills coming up today!'

Spoilar thought about the man's plea. Suddenly, a strange thought hit him. 'Wasn't the neuron you manned the same sort as mine?'

'Yes.'

'Well, look. I've just replaced my neuron with another like it, as we all do occasionally. Why don't we take my entire bath over to the old position of yours? Then won't it still be the same experience brought about in five minutes that it would have been with the old neuron if we fire this then, since this one is just like the old one? Surely the bath's identity means nothing. Anyway, then we can bring the bath back here and I can use the neuron for the experience it is scheduled to be used for later on. Wait a minute! We both believe the condition of topology is baloney. So why need we move the bath at all? Leave it here; fire it for yours; and then I'll fire it for mine. Both experiences must still come about. Wait a minute again! Then all we need do is fire this one neuron here in place of all the firings of all neurons just like it! Then there need be only one neuron of each type firing again and again and again to bring about all these experiences! But how would the neurons know even that they were repeating an impulse when they fired again and again? How would they know the relative order of their

firings? Then we could have one neuron of each sort firing once and that would provide the physical realization of all patterns of impulses (a conclusion that would have been arrived at merely by consistently disregarding the necessity of synchronization in the progress from parted hemispheres to parted neurons). And couldn't these neurons simply be any of those naturally firing in any head? So what are we all doing here?'

Then an even more desperate thought hit him, which he expressed thus: 'But if all possible neural experience will be brought about simply in the firing once of one of each type of neuron, how can any experiencer believe that he is connected to anything more than this bare minimum of physical reality through the fact of his having any of his experiences? And so all this talk of heads and neurons in them, which is supposedly based on the true discovery of physical realities, is undermined entirely. There may be a true system of physical reality, but if it involves all this physiology we have been hoodwinked into believing, it provides so cheaply for so much experience that we can never know what is an actual experience of it, the physical reality. And so belief in such a system undermines itself. That is, unless it's tempered with Cassanderish principles.'

The other thinker, coincidentally also named Spoilar, came to the same conclusion somewhat differently. He enjoyed stringing neurons. Once he got his own neuron, the one he was responsible for, in the middle of a long chain of like neurons and then recalled he was supposed to have it hooked up to the cartridge for a firing. Not wanting to destroy the chain, he simply hooked the two end neurons of the chain to the two poles of the impulse cartridge and adjusted the timing of the cartridge so that the impulse, travelling now through this whole chain, would reach his neuron at just the right time. Then he noticed that here a neuron, unlike one in usual experience, was quite comfortably participating in two patterns of firings at once—the chain's, which happened to have proximity and causal connection, and the programmed experience for which it had fired. After this Spoilar went about ridiculing 'the condition of neural context.' He'd say, 'Boy, I could hook my neuron up with all those in your head, and if I could get it to fire just at the right time, I could get it into one of these programmed experiences as fine as if it were in my bath, on my cartridge.'

Well, one day there was trouble. Some men who had not been allowed to join the project had come at night and so tampered with the baths that many of the neurons in Spoilar's vicinity had simply died. Standing before his own dead neuron, staring at the vast misery around him, he thought about how the day's first experience must turn out for the experiencer when so many neuron firings were to be missing from their physical realization. But as he looked about he suddenly took note of something else. Nearly everyone was stooping to inspect some damaged equipment just under his bath. Suddenly it seemed significant to Spoilar that next to every bath there was a head, each with its own billions of neurons of all sorts, with perhaps millions of each sort firing at any given moment. Proximity didn't matter. But then at any given moment of a particular pattern's being fired through the baths all the requisite activity was already going on anyway in the heads of the operators—in even one of those heads, where a loose sort of proximity condition was fulfilled too! Each head was bath and cartridge enough for any spread-brain's realization: 'But,' thought Spoilar, 'the same kind of

physical realization must exist for every experience of every brain—since all brains are spreadable. And that includes mine. But then all my beliefs are based on thoughts and experiences that might exist only as some such floating cloud. They are all suspect—including those that had convinced me of all this physiology in the first place. Unless Cassander is right, to some extent, then physiology reduces to absurdity. It undermines itself.'

Such thinking killed the great project and with it the spread-brain. Men turned to other weird activities and to new conclusions about the nature of experience. But what these were is another story.