Biological neural networks in psychiatry and psychotherapy

I am very pleased to be back in St Petersburg and also glad to make a small contribution to this conference.

I trained in medicine, psychiatry, group-analysis and recently EMDR and have now completely retired from clinical practice. Today therefore I will offer some observations on my life's work and interests.

My talk will review the history of neural network research and the application of theories of neural networks to clinical practice. My view is that the network within us and the networks around us are central components in our psychology and psychopathology.

This talk starts with the search for a scientific psychology which has been developing since the latter half of the 19th century.

Towards the end of the 19th century neuroscientists had become aware that the nervous systems of animals comprise interconnected nerve cells constituting a network. Eccles in his 'Physiology of Synapses reviews this history and records histologists discovering 'a complex net like structure in which nerve cells were first described as the nodes of a reticular structure' by Gerlach (1871).

The functions and nature of the reticulum was explored by many eminent scientists including Hughlings-Jackson, Korsakow, Meynert, Sigmund Freud in his 'Project for

a Scientific Psychology' and 'Beyond the Pleasure Principle.', together with Sherrington for his 'Integrative Action of the Nervous System', Pavlov and Bekhterev,

The greatest of all of these neuroscientists was, I believe, Santiago Ramon y Cajal who in his huge two volume work 'Histology of the Nervous System' drew every neural network of the mammalian brain and spinal cord. [I would personally now see this as perhaps one of the greatest individual scientific works of all time!].

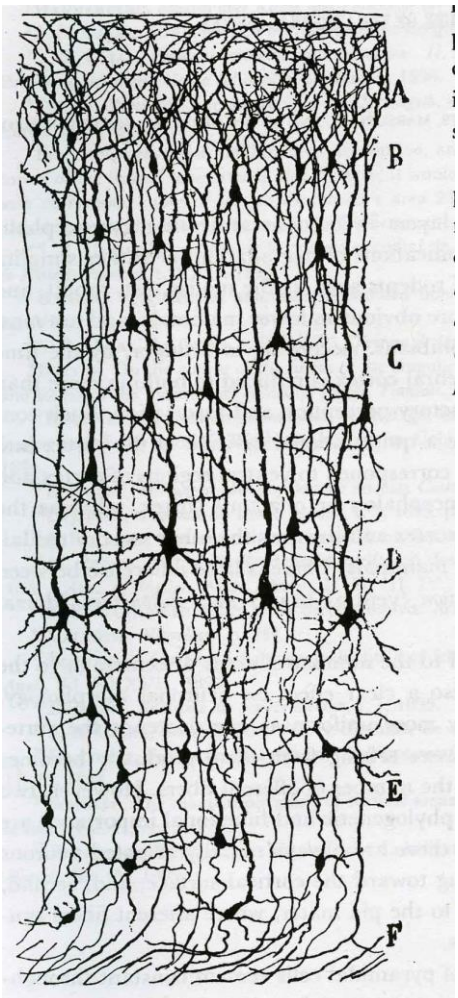

FIG. 528. Cerebral cortex of the 20-day-old mouse. Golgi method.

A, plexiform layer; *B*, small pyramidal cell layer; *C*, medium-sized pyramidal cell layer; *D*, large pyramidal cell layer; *E*, ovoid or polymorphic cell layer; *F*, white matter.

In 1897 Sherrington termed the junctions between nerves 'synapses'. from his work on reflexes, of the spinal cord he identified the existence of both excitatory and inhibitory activity at these synapses.

Cajal furthermore clearly demonstrated that the reticulum of the nervous system was not an unbroken network but comprised a multitude of junctions between its component nerve cells across which nervous impulses would pass. He drew many variations of the junctions between nerves. These in his 'Histology of the Nervous System of Man and the Vertebrates, published in Spanish in 1904 he calls synapses. Presumably following Sherrington.

From this it was apparent that the nervous system as a whole was achieving stability through the balance of inhibitory and excitatory processes as implied in Hughlings-Jackson's work on the march of an epileptic fit. Epilepsy is clearly a condition in which 'excitation' has 'run away' when the balancing process has failed.

Freud's great work of psychoanalytic discovery and very large oeuvre was inevitably flawed and failed to correct a number of errors in understanding of physiology and about human nature. One of his errors was a fundamental misunderstanding in his Project for a Scientific Psychology of the machinery for homeostasis of the CNS. Sherrington by 1905 had clarified the presence of a balancing of inhibition and excitation in the spinal cord and it has since been demonstrated beyond doubt that the whole system achieves balance by intricate interactions between excitatory and inhibitory mechanisms. This immediately renders Freud's pleasure versus unpleasure

essentially incorrect. Freuds attempt to construct a mind based on a unipolar excitation only, nervous system was doomed to failure from the start and despite his ingenuity was indeed abandoned by him as a failure as soon as he began to develop concepts related to early psychoanalysis. Unfortunately despite abandoning the project he did not abandon his pleasure/unpleasure polarity and was to pursue theories based on a misperception of physiology. His project remains nonetheless a laudable early attempt at interpreting the biological neural network and was for instance praised not only for its pioneering qualities but also for its foresight by Pribram (1962).

Between 1900 and 1940 behaviourism was a developing science and psychoanalysis continued its development leaving behind early work on hysteria and attending largely to oedipally related neuroses. Pavlov completed work on classical conditioning 1927/1960 and Skinner 1938 advanced this work exploring and developing applications of operant conditioning. Behaviour therapy was developed as a method between 1950-1960.

In 1943 a neurophysiologist McCulloch and a mathematician Pitts wrote a paper on how aggregations of neurones might work and modelled a simple neural network using electrical circuits. 1949 Hebb wrote his book on 'The Organisation of Behaviour' advancing ideas about information processing in Neural Networks by proposing that usage of neural pathways becomes the basis of learning . This work would become the foundation of attempts to understand the biological neural network and to develop computer models of mental processes.

In 1959 electron micrographs were taken which showed clearly the separation of the cells joined by synapses and intensive investigation thereafter was to demonstrate that the electrical continuity of the nervous system is supported by the release of micro - packages of chemicals at the synapses which provoke a nervous impulse in the next neurone in the chain.

This is an early electron micrograph, from Gray (1963)

In 1960 J Z Young, a distinguished biologist published 'A Model of the Brain' in which he set out a research project directed at the Octopus in order to demonstrates how a brain worked. He worked on a model of the brain and also key issues of models (and maps) in the brain. A key message was that the organism is a potentially self aware (HBs) and self organising homeostat whose function is to adapt to his or her environment.

Neural networks have become increasingly important in developing computer programmes which can carry out tasks of self regulation and information processing. The programmers and developers have sought simulated intelligence basing their work on assumptions about the functions of the central nervous system. We are now reaping the benefit of the latter with the rapid progress in the field of AI which has currently peaked with driverless car and a computer which can win at Go. We are also aware of enormous networks of computers the largest of all being the internet and within that many smaller networks such as facebook and linked-in.

In Sherringtons Man on His Nature he , in a remarkable tour de force describes his vision of 'the cerebral cortex in action, which has been in some ways validated by the latest work with multiple microelectrodes in the Europe wide Human Brain Project. This is a state of the art attempts to build a computer model of the entire brain based on multicentre contributions from neurophysiologists and computer scientists.

Sir Charles Sherrington: 'The enchanted loom'

Should we continue to watch the scheme we should observe after a time an impressive change which suddenly accrues. In the great head-end which has been mostly darkness spring up myriads of twinkling stationary lights and myriads of trains of moving lights of many different directions. It is as though activity from one of those local places which continued restless in the darkened main-mass suddenly spread far and wide and invaded all. The great topmost sheet of the mass, that where hardly a light had twinkled or moved, becomes now a sparkling field of rhythmicflashing points with trains of travelling sparks hurrying hither and thither. The brain is waking and with it the mind is returning. It is as if the Milky Way entered upon some cosmic shuttles weave a dissolving pattern, always a meaningful pattern though never an abiding one; a shifting harmony of subpatterns. Now as the waking body rouses, subpatterns of this great harmony of activity stretch down into the unlit tracks of the stalk-piece of the scheme. Strings of flashing and travelling sparks engage the lengths of it. This means that the body is up and rises to meet its waking day.

Dissolving pattern after dissolving pattern will, the long day through, without remission melt into and succeed each other in this scheme by which for the moment we figure the brain and spinal cord. Especially, and with complexity incredible, in that part which we were thinking of, the roof-brain. Only after day is done will it quiet down, lapse half-way to extinction, and fall again asleep. Then at last, so far at least as the roof-brain, motor acts cease. The brain is released from the waking day and marshals its factors for its motor acts no more.

Network Activity in the Brain.

It is to my mind almost certain that the activity described by Sherrington and demonstrated in the HBP as activity of a neural network is one of the 'neuronal correlates of consciousness and in effect an externally observable indicator of 'the ***stream of consciousness of the human being***!

The stream of consciousness is something Freud studied directly through free association and has also been represented in all its complexity and beauty by a series of novelists. Proust, James Joyce and Virginia Woolf are pioneers of this kind of writing and I will add a great Russian author Dostoevsky to this select list. 'Crime and Punishment' gives close attention to the mental life of its hero and 'Memoir from a Dark Cellar' is identified as a full adoption of the genre.

The stream of consciousness of a human being becomes coherent as a gestalt in early infancy and can flow with growing power width and depth as life progresses. Analysis can unblock a frozen, divided, fragmented or interrupted stream and allow a damaged life to regain direction and force.

Extract from 'Portrait of the Artist as a Young Man'. James Joyce (1916).

Once upon a time and a very good time it was there was a moocow coming down along the road and this moocow that was coming down along the road met a nicens little boy named baby tuckoo.
His father told him that story: his father looked at him through a glass: he had a hairy face.
He was baby tuckoo. The moocow came down the road where Betty Byrne lived: she sold lemon platt.[1]

0, *the wild rose blossoms*
On the little green place.

He sang that song. That was his song.

0, *the green wothe botheth.*

When you wet the bed first it is warm then it gets cold. His mother put on the oilsheet. That had the queer smell.
His mother had a nicer smell than his father. She played on the piano the sailor's hornpipe for him to dance. He danced:

Tralala lala
Tralala tralaladdy
Tralala lala
Tralala lala.

Uncle Charles and Dante clapped. They were older than his father and mother but uncle Charles was older than Dante.

It is yet to be clarified whether the conscious ego arises as a growing whole or in fact crystallizes from a group of islands of protoconsciousness.

I particularly like T.S. Eliot's poem Animula which describes the emergence into life of a new pristine conciousness which becomes progressively corrupted and spoiled by its journey through the temptations and traumas of life.

Animula

lssues from the hand of God, the simple soul'
To a flat world of changing lights and noise,
To light, dark, dry or damp, chilly or warm;
Moving between the legs of tables and of chairs,
Rising or falling, grasping at kisses and toys,
Advancing boldly, sudden to take alarm,
Retreating to the corner of arm and knee,
Eager to be reassured, taking pleasure
In the fragrant brilliance of the Christmas tree,
Pleasure in the wind, the sunlight and the sea;
Studies the sunlit pattern on the floor
And running stags around a silver tray;
Confounds the actual and the fanciful,
Content with playing-cards and kings and queens,
What the fairies do and what the servants say.
The heavy burden of the growing soul
Perplexes and offends more, day by day;
Week by week, offends and perplexes more
With the imperatives of 'is and seems'
and may and may not, desire and control.
The pain of living and the drug of dreams
Curl up the small soul in the window seat
Behind the *Encyclopaedia Britannica.*
Issues from the hand of time the simple soul
Irresolute and selfish, misshapen, lame,
Unable to fare forward or retreat,
Fearing the warm reality, the offered good,
Denying the importunity of the blood,
Shadow of its own shadows, spectre in its own gloom,
Leaving disordered papers in a dusty room;
Living first in the silence after the viaticum.
Pray for Guiterriez, avid of speed and power,
For Boudin, blown to pieces,
For this one who made a great fortune,
And that one who went his own way.
Pray for Floret, by the boarhound slain between the yew trees,
Pray for us now and at the hour of our birth.

Thomas Stearns Eliot, from Ariel Poems 1929

It is almost certain that we are all waylaid and damaged by the multiplicity of small and large traumata lying in wait for us and sometimes a mighty river of consciousness is brought to a terrifying vortex at its ending, as in Conrad's anti-hero Kurtz in The Heart of Darkness whose last words are 'the horror, the horror!'

Such is what our patients bring us.

Dissociative Splits in the Stream of Consciousness, caused by traumatic experiences.

Animulae are likely to all encounter at some point in their lives trauma with a large or small t. As a result from birth the smooth flow of a stream of consciousness is unlikely. Traumatic experience is unbelievably common! And one of its complications is splitting of the ego!

Despite this there is a presumption of the unity of consciousness, so that the individual is considered to be an integrated whole.

The stream of consciousness may in fact be a much divided thing! Freud and Breuer in their early cases were witness to this. They studies a series of cases of dissociation and dissociative disorder. But were to both move on to other things, essentially leaving the field of dissociation incompletely resolved.

Every trauma interrupts and can divide the stream of consciousness. This would appear to have been the case in the singer in Schoenberg's monodrama 'Ewartung (Expectation)'. The libretto for this work was written by a medical student Marie Pappenheim who was probably a cousin of Bertha Pappenheim also known as Anna O, one of Breuer's patients from studies in hysteria.

The subject of 'Ewartung' wanders in a dark and sinister forest. (For me, noting Cajal's pictures, rather like wandering lost through one's own neural network). She is searching for her lover and is to eventually find his lifeless body! The text is intentionally ambiguous, but her horror is that she is in a dissociated state and had almost certainly murdered him in a fit of jealousy.

Such dissociation can be resistant of therapy and may derail EMDR. It requires great skill to bring all the parts of a dissociated self into therapy and to confront the reality of divisive unbearable trauma in a way which enables reparation of conscious integrity.

Conclusions of a Group-Analyst and psychotherapist.

Freud began his work as a psychoanalyst at the point when he decided to observe and comment on the stream of consciousness of his patients. It is from this work that all of the psychodynamic therapies have developed, including of course Group-Analysis.

My intention now is to look at several areas in which the knowledge of neural networks can be applied to modern psychotherapy. Today I shall highlight three area of application.

1. The healing stream. EMDR (.. activating optimal neural network processing)

EMDR attempts to actively facilitate processing of traumatic experience through active information processing in the neural networks of the cerebral cortex, as with Freud and Breuers work with post traumatic 'hysteria', EMDR has been likened to 'chimney sweeping'. It has emerged as an unusual therapeutic technique since the pioneering efforts of Francine Shapiro during the 19xxs.

From an initial serendipitous discovery, of Shapiro, when out walking and ruminating over persecutory personal issues the method has evolved to offer comprehensive curative treatment for a growing range of psychiatric disorders. In essence bilateral stimulation, ultimately of neural networks of the cerebral cortex, promotes processing of intolerably painful traumatic memories and the correction of negative cognitions embedded in the memories of the traumatic experience. The results are very encouraging and research has demonstrated enduring 80-90 % improvement in established PTSD. Treatment requires meticulous adherence to a written protocol. A

relationship of complete trust in the therapist is required which will have been built during exploratory interviews establishing chains of traumatic memory and work on building a state of comfort and safety.

I would like to emphasise a contrast with CBT in which this method leads to a natural (re-)acquisition of new positive cognitions which empower the patient and are not eroded by the passing of time.

EMDR was a refreshing new experience for one who had in the past had many interminable patients who despite prolonged analytic therapy seemed wedded for all time to negative beliefs about themselves, blocking all hope of growth and maturation!

Early in her work Shapiro adopted the term neuronetworks, an avoidance of claiming full neurobiological parallels. Later works sees the EMDR process firmly located in the neural networks of the forebrain and midbrain

My EMDR experience includes being truly astonished to see a traumatised patient reporting mental content (in a stream of consciousness) as they rapidly process traumatic events, demonstrating a natural healing powers which I had never expected.

2. The complex stream of Group Associations. (Group -analytic psychotherapy).

In developing the concept of a group matrix Foulkes showed awareness of the neural network within the individual and applied in his method the processing power of

networks of individuals in small median and large groups. The potential processing power increases with the size of the group.

As a biologist I was a therapist who expected all my patients to be naturally adaptive. Freud was also a biologist and conducted early therapies expecting his patients to rapidly adapt to insights gained through analysis. His early patients seemed to do this. Foulkes also saw his groups as promoting a natural thrust towards health.

Foulkes did his best to understand the power of his groups. His most successful attempt at this was through his idea of the group matrix. He thus proposed the individual group member as being like the nerve cell as a nodal point in a group matrix. He saw the individual as small part in a larger matrix and saw the power of the group as lying in an external network of interacting minds.

Quotes from my matrix paper!

> *'The matrix is the hypothetical web of conununication and relationship in a given group. it is the Common shared ground'*

He usefully extends this definition when he says:

> *"The social matrix can be thought of as a network in quite the same way as the brain is a network of fibres and cells which together form a complex unit. In this group network all processes take place and in it the can be defined with regard to their meaning, their extension in time and place and their intensity".* (Foulkes and Anthony 1965).

Again and again the word network occurs so that it becomes almost synonymous with matrix, and Foulkes enlarges on this when he says:

"The group matrix is the operational basis of all relationships and communications. Inside this network the individual is conceived as a nodal point. The individual, in other words, is not conceived as a closed hut as an open system. An analogy can be made with the neuron in anatomy and physiology, the neuron being the nodal point in the total net work of the nervous system which always reacts and responds as a whole (Goldstein). As in the case of the neuron in the nervous system so is the individual suspended in the group matrix".
(Foulkes 1964).

"Looked at in this way" (he continues), *"It becomes easier to understand our claims that the group associates, responds and reacts as a whole. The group as it were avails itself now of one speaker, now of another but ills always the transpersonal network which is sensitized and gives utterance or responds. In this sense we can postulate the existence of a group mind in the same way as we postulate the existence of an individual mind".*

A good group can exercise the power of multiple streams of consciousness. And a good median group even greater potential power. Our challenge is how to liberate it.

My observation at the Ingrebourne Centre and in my small therapeutic groups was that the power was not always for the good and indeed powerful therapeutic forces can encounter powerful antitherapeutic forces. I outlined these in my early paper 'Destructive Processes' in Therapeutic communities and a later paper 'Destructive Processes in Groups. Morris Nitsun was to later term these processes 'The Anti-Group'.

It is a simple step to invokes Freud's death instinct at this point, which might lead to a fatalistic and powerless approach. It is probable however that every therapist has the power in his hands to maximise the therapeutic as opposed to the anti-therapeutic power of his/her groups. It is a comparatively simple matter to ensure that in the setting up of a group articulate and well motivated neurotic patients outnumber more disturbed and damaged individuals, particularly borderline personalities who bring an excess of their own 'death instinct' to the group.

3. The divided stream. Problems emerging from sufferers of dissociation.

The EMDR therapist is advised to screen for dissociative phenomena in his patients using the DES. Usage of this tool results in identifying:

1. Normal dissociation.
2. Moderate pathological dissociation (PTSD).
3. Severe and persistent dissociative disorder often following complicated and multitrauma PTSD.
4. Complex PTSD.
5. DID
6. A null result despite obvious abnormality which may for instance constitute a severe dissociation between psyche and soma as for instance evidenced in alexithymic conditions and body awareness disorders.

And finally, not yet allocated on the consciousnessness disorder spectrum. ADHD and Autistic Spectrum Disorder conditions.

Freud and Breuer began their work as therapists of hysteria, working intensively with mostly young women suffering from conditions which would now be included in the dissociative disorders.

These conditions are those in which there has been a division of the stream of consciousness following a traumatic experience. The result is subsequently a disruption of function in the neural network in which one or more autonomous sub systems may arise and produce puzzling symptoms and what will be observed as a loss of integrity and authenticity in the person.

I believe such cases are surprisingly common but have been disconcerted throughout career to find mainstream psychiatry scarcely acknowledges the existence of dissociative disorders and has banished this body of pathology together with Freud to occupy the place of non scientific and purely literary and fictional phenomena.

4. The fragmented stream. (Treating the Schizophrenic illness.)

A very large body of research now suggests that the neural networks of those suffering from a schizophrenic illness are seriously compromised. It would appear that the sufferer has a significantly reduced level of connexity of the neurones of his/her cortex and furthermore that there is a simultaneous tendency towards spurious connections. It is not therefore surprising that symptoms of this disorder amount to multifarious abnormalities of the experience and performance of consciousness.
The properties of those suffering schizophrenia are those of people suffering unpredictably variable disorders of their stream of consciousness. As a result the

following features of a person suffering schizophrenia should be dictate the behaviour of their therapists.

- High in death instinct.
- Qualitatively different from neurotic patients.
- They are naturally unreliable.
- They are highly sensitive and vulnerable.
- The low connexity of the person suffering schizophrenia means a natural tendency to experience painful inner emptiness. A special personal horror. It may well be the case that this emptiness is multiplied 10 – 1000 fold by over medication.

What are they like in groups. They may have peculiar insights into others . They may well not be understood by neurotics. They add to the disorder. (Death instinct) in the group.

But other group members can become auxiliary egos and the enriched mental life of the group can be internalised as an improvement in the connexity within the sufferer from schizophrenia.

The shchizophrenia sufferer can be stabilised in a group, be buffered against destructive behaviour and little by little regain ego strength and resilience.

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