

A brief functional overview of the brain: thinking about thinking as you start clinical training in neurodevelopment

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An invitation for your brain to think about itself

Understanding the brain in a way that is readily usable in clinical practice during our day-to-day work focuses on brain *function* first and *structure* second, and on the way our brains help us adapt to the world around, in particular, rather than “spotting the lesion”. Normal brain development and function is set as a backdrop to clinical work, rather than brain pathology. The brain as the communication centre between the outside world and the internal milieu of our bodies is highlighted, together with the transformation of our goals, our needs and our intentions, into action. Dealing with the world of the child, or young person, and their family, as represented within their brains and expressed in their actions, is the daily task we grapple with each day as experienced clinicians.

But to do this we must start with what tools we will use, what skills we will employ and what resources we will muster for such a task. We are immediately faced with a possible problem. We must use the tools, our brains, to examine the tools, our patients’ and their families’ brains. We must examine their inner - verses with our inner-verses, even when we utilize some marvelous tools in the outer-verse, to do so. We must use skills, shaped by our constraints and limits, to work within their constraints and limits, to encourage them to move beyond the constraints and limits that have brought them to us for help. We must garner our resources of time, effort, motivation, emotion and cognition, to address and mobilize their time, effort, motivation, emotion and cognition, on their behalf. To do this is a little like undertaking the repairing of a boat while having to keep it afloat and rescue another fellow mariner in the river of life.

This brief introduction is a first attempt to help in that rather wobbly enterprise, without sinking both boats in the process. It is a modest task but important enough to take a little time examining what it is that keeps us afloat most of the time - our brains and the brains of those we love about us. If you see a word you don’t understand, just pass over it for another time. Some of the jargon around brain sciences is the worst in science and medicine. Try to let it be like the warts and skin tags we have that no-one else knows about. It’s a nuisance but we can live with them, as long as we don’t become obsessed with getting rid of them or working out how they came to be there.

Information In - Action Out and Everything in between is Interpretation

Multicellular organisms have evolved nervous systems, and heads to contain them, to provide centralized communication, interpretation, and command systems for the body. We may experience ourselves as individuals but each of us is much more like a Parliament of the Self and no single structure of the brain

“is an island, Entire of itself.

Each is a piece of the continent of the Self, part of the Brain.

If a part be washed away by life, the Self is the less.

As well as if a promontory were.

As well as if a manor of thine own, or of thine friend's, were.

Each structure's death diminishes me,

Each structure involves all my humanity.

Therefore, send not to know for what the structure does,

It does for Thee. (with Apologies to John Donne)

Nervous systems enable rapid, high-fidelity communication, together with rapid, formulaic responses. Human nervous systems also provide slower, more reflective and finessed responses.

What is going on outside the body is registered, based on sensory experience, impinging upon the body, concentrated around the head, with the main portals of sensory in-flow being the sensory cranial nerves. "*Nothing is in the mind that is not first in the senses...except the mind itself*".

Sensation from the body - *somatosensory information* - is conveyed to, and represented within, the brain. For practical purposes the body, other than the brain, is also regarded by the brain as part of its environment. Somatosensory information is gathered towards the back of the brain behind the great divide between sensory in-put and motor out-put. This valley that stretches from ear to ear across the brain - the Central Sulcus - only appears clearly and fully in the third trimester of pregnancy. In front of this great valley, or sulcus - all is action (*motor*), preparation to action (*premotor*) or intent to action (*prefrontal*). Behind it, all is sensory experience of the world beyond the brain. From front to back, the brain stretches from broad-brushed intentions to almost digitally received visual impressions of the world around.

The Body beyond the Brain

What is going on inside the body itself - *viscerosensory information* - is detected via the autonomic nervous system. This bodily information is represented within the brain and has privileged status within the borders of the Self, patrolled for alien incursion and protected by distaste, nausea and disgust. If deemed a threat, the body will eject the offending incursion by vomiting, inflammation, withdrawal or active avoidance. Viscerosensory information is represented in the strip of tissue, or gyrus, just behind the Central Sulcus giving almost digital detail on the environment's impingement on the

body. This is placed into the context of where the body is in space in the Precuneus - a small area in the “Where is it?” section of the brain called the parietal lobes.

Viscerosensory information is also placed within the context of what is happening throughout the entire body, in the Insula, which gives a report on “The State of the Union” between all the body parts. Unlike the great speech by the President in the United States, the report of the State of the Union operates in real time, not just once a year.

The tissue on the outside 3 millimetres of the brain contains many of the nerve cells (gray matter) that process information while the white matter in the depths of the brain conveys and connects the information in insulated nerve fibres. The gray matter reminded someone a long time ago of the bark of a tree and was named the cortex, after the Latin word for bark. What is going on inside and outside of the body is interpreted and integrated within the areas of the cortex where different types of “bark” come together. These association cortices (secondary and tertiary cortices - convergence cortices) combine sight, sight, touch and smell at the meeting points between them to place within the narrative of our lives.

If you have an A-Z of the Brain, now is the time to use it

Finally, when we do something about what is going on, or what is required, or whatever we have a purpose to accomplish, the brain transforms necessary responses, needs and goals, into action. When this action is directed to the outside world, it is termed, *somatomotor*, and when it is directed within the body, it is termed, *visceromotor*. Somatomotor function is represented and regulated by the motor cortical systems anterior to the Pre-Central Gyrus and organized and finessed by the Basal Nuclei and the Cerebellum. The Basal Nuclei are islands of gray matter submerged in the depths of the brain for specialized motor processing and memory of action sequences. The Cerebellum is the little brain at the back and beneath the main Cerebral Hemispheres which refines all that goes in and out of the brain, without fuss or fury, almost beyond our awareness, to create *the Implicit Self*, against which any construct of the Self-in-action is monitored.

I told you there might be some unfamiliar words and jargon. About fifty terms should see you able to navigate your way around the brain. We shall cover these in installments to come. Try to read some of them without developing an immediate phobic response and as time goes on you will know all you need to know to stop neuroscientists from engendering stupor, torpor, terror or anger as you listen to us addressing you in a thoughtlessly, unempathic way.

Here we go:-

Visceromotor responses (gut, internal organ reactions and feedback) are mediated through the autonomic motor pathways. A key part of interpreting the environment is interpreting other people, especially their faces (Fusiform Gyrus - tucked underneath on the temporal lobe) and their non-verbal behaviour (Basal Nuclei / Insula), but also their verbal behaviour (Wernicke's Area). Threats (Amygdala), rewards, opportunities, reinforcers (Nucleus Accumbens), and punishment (Peri-Aqueductal Grey Matter) all require to be, and can be, detected by the brain. Remembering the past to more effectively

handle the present and the future, is achieved by memory (Hippocampus, Frontal systems, Basal Nuclei and Amygdala). Constructing likely futures, or wished-for futures, or threatening futures, involves executive function (Prefrontal and Cingulate cortices). Constructing what is happening in someone else involves imagination and empathy (Fronto-insular cortices). The ability to attend, focus, and concentrate (Anterior Cingulate Gyrus) on particular parts of the environment, in order to solve problems (Prefrontal Cortex), adapt to new situations, and maintain stability of daily living - homeostasis (Hypothalamus) - all involve specific areas and circuits of the brain. Error detection, avoiding unwanted responses (Cingulo - Striate Cortex), retaining patterns of wanted responses, and automating responses (Basal Nuclei), especially in regards to other people (Insula) - emotions - are part of the ordinary activity of nervous system function.

Play it again Sam....

Just read that one more time - this time without the jargon and technical language - and let's hope it won't seem so bad

Gut and internal organ reactions and feedback are mediated through the nerves that supply these organs. A key part of interpreting the environment is interpreting other people, especially their faces and their non-verbal and verbal behaviour. Threats, rewards, opportunities, reinforcers, and punishments all require to be, and can be, detected by the brain. Remembering the past to more effectively handle the present and the future, is achieved by memory. Constructing likely futures, wished-for futures, or threatening futures, involves executive function. Constructing what is happening in someone else involves imagination and empathy.

The ability to attend, focus, and concentrate on particular parts of our environment, in order to solve problems, adapt to new situations, and maintain stability of daily living - *homeostasis* - all involve specific areas and circuits of our brain. Error detection, avoiding unwanted responses, retaining patterns of wanted responses, and automating responses, especially in regards to other people - *emotions* - are part of the ordinary activity of nervous system function.

Phew....does that feel better, or is the post jargon stress disorder (PJDS) still with you?

The End of the Beginning

Over subsequent weeks, you will be able to gain a developmental understanding of the brain from conception to the middle of the third decade of life, when frontal maturity is normally complete. We will emphasize gender differences, environmental stressors and toxicity, together with genetic unfolding of neuro-vulnerability.

For this introduction, I have elaborated one very simple idea: there is sensory in-put, there is motor output and there is interpretation of both in the in-between-ness (association cortices). What we receive and what others send must be distinguished to check that what is received by us is what was sent. What we send must be partialled out from what our patients receive. We must check that what they received is what we sent. Much time needs to be given to our interpretation of what is sent *to* us and their

interpretation of what is sent *from* us and the subsequent responses. Much of this happens outside our awareness. It also happens outside the awareness of our patients, their families and those friends, teachers and workmates who may confuse what was intended in a communication from what was received.

Of course, the problem from where we started – brains thinking about brains – may be an asset as well as a liability. Sometimes, sharing nervous system features in common with those we are asked to help may also give us unique insights into the difficulties they are having. If we are having trouble helping because of obstacles, they may be having difficulty because of related obstacles. Well, of course my new colleagues, you knew all of this all along and there will be many times when discovering more about the brain is really a re-discovering of what you have always known. But sometimes it is this return to where we started that is the getting of wisdom because now it all looks so different and so much has changed as the philosophers and poets tell us.

REFERENCES

Basic

Nunn, K.P., Hanstock, T. and Lask, B.L. (2008) *Who's Who of the Brain* Jessica Kingsley Press: London

Intermediate

Powerpoint presentation for session:

The 3-D Brain free application on i-Pad or i-Phone is excellent

Advanced

Carter, R (2003) *Mapping the Brain Phoenix*: London