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Biological Substrate of the Neurotyping Axes

The following is an attempt at framing the Neurotyping system put forth by Digibro through the lens of network analysis, thereby providing the system with a naturalistic grounding and additional validity.

Skip to the 'Overview' section for a TL;DR diagram.

Hemispheric Specialization

As I was thinking about the Neurotyping system, I noticed a connection between the Lexical-Impressionist axis and the hemispheric asymmetry of the human brain, in particular, the language centers of the brain (which are typically found in the left hemisphere). Given the connection between language and Lexicality, it seems straightforward to suggest that the bifurcation implied by the Lexical-Impressionist axis and the bifurcation of function which occurs in the brain due to hemispheric differentiation are connected. Hemispheric asymmetry is a well-documented phenomenon in the human brain (Toga & Thompson, 2005), so using it as a basis for a system attempting to categorize methods of thinking should yield a robust result.

Furthermore, as I researched into what causes hemispheric specialization, I found an article that connects it to variations in the hemispheric connectomes (how the neurons in the hemispheres connect to other neurons), both intra-areally and inter-regionally:

"...hemispheric asymmetries in structural connectivity are a fundamental constraint of brain architecture and may be the cause for functional hemispheric specialization. These hemispheric differences in structural connectivity, which have been found both at the level of intra-areal microcircuits and inter-regional connections, are likely to form the structural substrate of different functional principles of information processing in the two hemispheres." (Stephan, et al., 2007).

For those interested in more info about hemispheric specialization, I would recommend the book *The Master and His Emissary* by Iain McGilchrist. I haven't read the entire book, but what I have read appears to me to be insightful and informative, as do some of the video lectures by the author. You can view a pdf of the book through the following link:
https://drive.google.com/file/d/1Jf0W0m8rCSR8Os99ohk70CnODcKnVJwB/view?usp=sharing

Network Variation

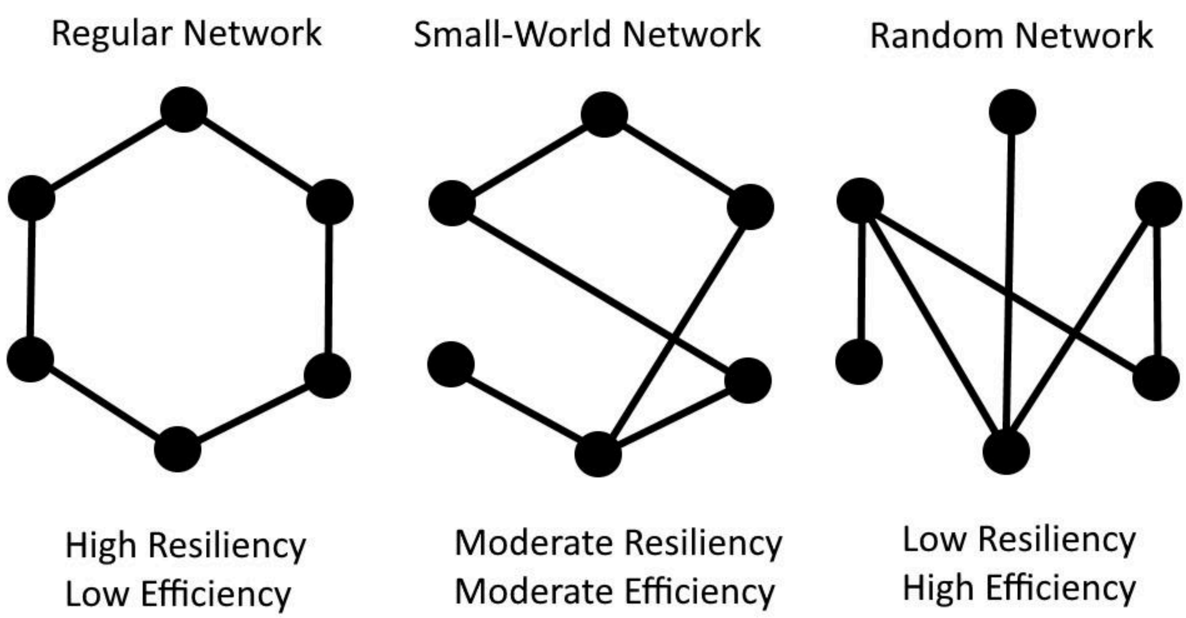
With regards to the Linear-Lateral axis of the Neurotyping system, the most straightforward grounding to me seemed to be in the variation in network connectivity, where Linear thinkers would have a relatively low number of connections between the various regions of the brain, and

Lateral thinkers would have a relatively large number of connections. Given that there are already a large number of analyses of the brain from the point of view of network analysis (viewing the brain as a network of nodes), lending credence to this type of analysis (Forneto, et al., 2016), this seems to be a rather safe place to obtain a naturalistic grounding for the Linear-Lateral axis. Furthermore, this grounding would allow this axis to be theoretically conjoined with the Lexical-Impressionist axis, as will be outlined later in this analysis.

Before proceeding further, the basic types of network connection patterns should be outlined.

Network Spatial Variability

The following three networks all have the same number of nodes and the same number of connections between the nodes. The only difference is the way in which the nodes are connected to each other.



Networks can be characterized by their resiliency (resistance to node isolation due to damage to the network) and efficiency (mean-path distance, average number of steps to go from one node to another node by traversing the connections between nodes). Networks can be organized into three general types based on their patterns of connectivity:

- Regular Network: Highly ordered, small distance connections between nodes. Resilient but not efficient.
- Small-World Network: Mostly ordered connections with a few long distance connections between nodes. Balance of resiliency and efficiency.

- Random Network: Random connections (mostly medium to high path length) between nodes. Efficient but not resilient.

To bring it back to the Linear-Lateral axis of the Neurotype system, it is likely that Linear thinkers tend to form a larger number of regular networks within their brain, while Lateral thinkers tend to form more small-world and random networks.

Recent research has suggested that there is a positive correlation between a brain's tendency to form small-world networks (i.e. Lateral thinking) and the general intelligence of the corresponding subject (Barbey, 2018). This likely explains the slightly positive correlation between higher IQ and higher Laterality in Digibro's initial version of the Neurotyping system. However, since small-world networking is alone not sufficient to generate general intelligence, the correlation, while significant, is not overwhelming. For a more comprehensive analysis of the physical substrate of general intelligence, see the paper on the parieto-frontal integration theory (Jung & Haier, 2007).

With regards to random networking, I would guess that this is found in apparently non-functional Lateral thinkers (who appear to make no sense to the outside world). One would think that this may be where those who appear autistic would be located within the Neurotyping system (as implied by Digibro in one of the earlier Neurotyping videos), but research has shown that autism is more connected with a lack of brain network interconnectivity rather than an excess or random distribution of interconnectivity (Rudie, et al., 2013). It may be that the actually autistic may be located near the Linear end of the Linear-Lateral axis (this is not to suggest that all Linear thinkers are autistic), while those who are apparently autistic (those who behave or appear to be "abnormal" due to their variance from the statistical norm, without the compensatory social skills to make up for that variance) are located near the Lateral end of the axis. The specific details of the network analysis in the Rudie, et al. paper are a bit more sophisticated that outlined above, so I would recommend at least reading the abstract of the paper to get a better idea of their findings.

There is also the apparent tradeoff between small-world optimization and overall robustness of a network, which is something that I have yet to read into, but which may prove to be a useful angle to consider things from (Peng. et al., 2016).

Network Temporal Variability

The previous sections focused on the spatial variation in networks. However, how networks vary in time is also relevant to this analysis.

The most evident way in which networks vary in time is by changing their connections in response to the environment (neuroplasticity). However, while the plasticity of the brain is an established finding (Kolb & Wilshaw, 1998), this again brings focus to the spatial structure of the network. Of interest would be the temporal behavior of a given network when its spatial structure is held constant. Such behavior can be assessed by assessing the firing patterns of neuronal networks.

Research has shown that neural synchrony (a set of neurons firing at the same time) is associated with cognitive integration, which is directly connected to one's ability to compress a given set of information. On the contrary, neural asynchrony is associated with cognitive disintegration and a greater focus on detail rather than the whole picture (Varela, et al., 2001).

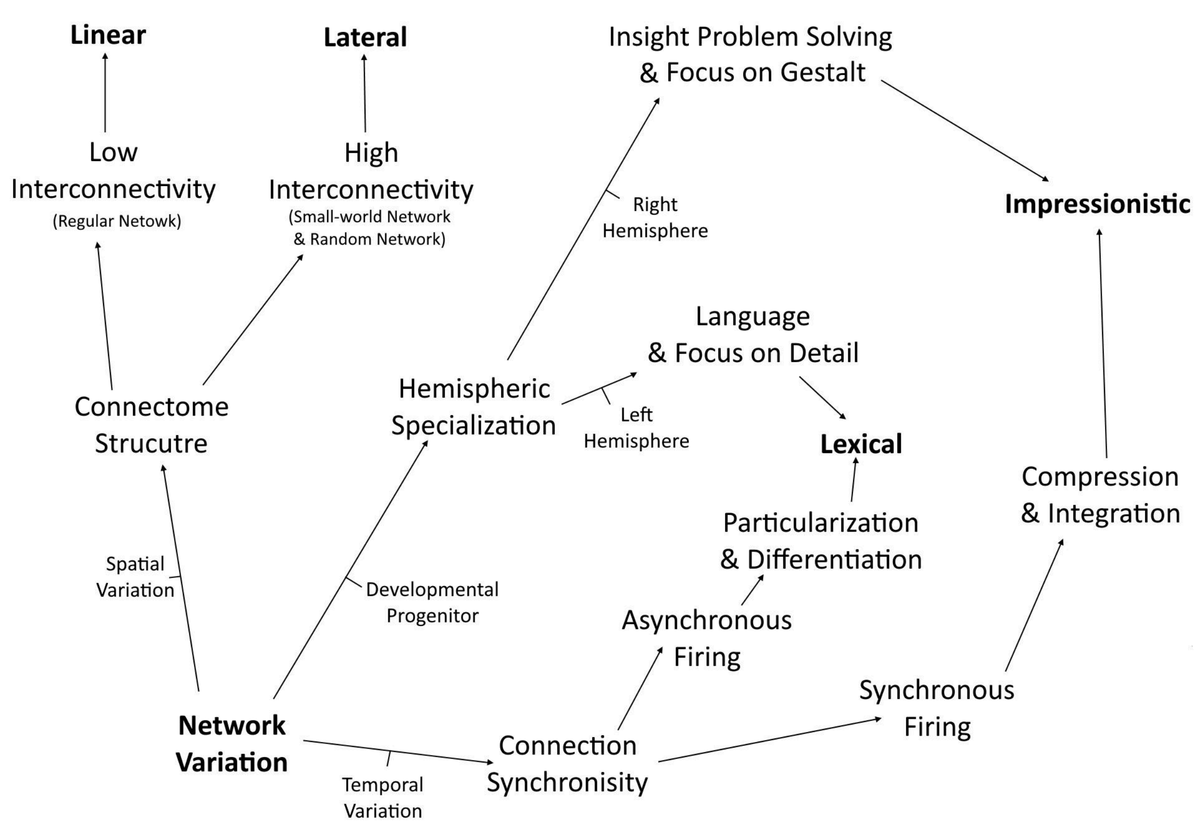

(If you haven't seen these images before, stare at them for a while and see if you can make out a picture that isn't just random black blots)

As an example, when viewing the two pictures above, if one does not know what to look for, the neural networks of that person's brain will undergo asynchronous firing as the brain focuses on the details of the image (the individual blots) as opposed to the "whole picture". The first person experience is one of confusion. However, once one sees what the image is depicting, that person will usually report an experience of an "Aha" moment, during which their brain will undergo a large degree of synchronous firing as the gestalt of the image is established (Spoiler: ~~both images contain a dog~~). It is common that once a person has seen what one of these types of images is depicting, then they have trouble "unseeing it", since the synchronous pattern established by the initial insight is so strong (Spoiler: ~~if you still don't see them, the one on the left is a dalmatian facing away from the camera, while the one on the right is a boston terrier facing towards the camera~~).

The connection between neural synchronicity and asynchronicity seems to me to be a straightforward connection between network variability and the Lexical-Impressionist axis. To bring it back to hemispheric specialization, recent research has shown that the right hemisphere is disproportionately activated during insight problem solving (which is the function of interest here in contrast to language) , lending further credence to the connection between hemispheric specialization and the split between the two ends of the Lexical-Impressionist axis (Jung-Beeman, et al., 2004).

Overview

The following chart is an attempt to graphically depict the contents of the sections above. It demonstrates the grounding of the Linear-Lateral and Lexical-Impressionist axes in a common naturalistic phenomenon: network variation.



It seems odd to me that the chart is asymmetric. I would guess that there is a way of connecting hemispheric specialization to the Linear-Lateral axis (maybe that Lateral thinking requires insight problem solving, although this would effectively collapse the two axes of the system into a single axis, which I don't think is warranted). Further research would be needed to assess this.

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For those interested in the implications of network connectivity, as well as a more general analysis of some of the concepts discussed in this document, I would recommend the video *Awakening from the Meaning Crisis - RR in the Brain, Insight, and Consciousness* by John Vervaeke. This video is right in the middle of a 50 episode lecture series, so if you don't have a background in the relevant fields you may find that you need to watch some of the earlier videos in the series in order to follow the arguments (I would recommend starting on episode 26 if you feel the need to do so, or start with episode 1 if you want the historical analysis in addition to the cognitive science analysis). You can access the video through the following link: https://www.youtube.com/watch?v=IZyWuD9UqI4

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