What makes a person unique?

By Michaela Dunn

What accounts for the differences in thoughts, emotions, and behaviors among individuals? This is a critical question in the field of personality neuroscience, and dispute still exists regarding the answer. The way a person generally thinks, feels, and behaves is loosely defined as their personality, and it largely affects an individual's ability to function in social contexts and in other parts of life. Dr. Colin DeYoung and others in the field describe personality based on the "Big 5" model; there are 5 "big" traits that can be used to concisely summarize the way a person thinks, feels, and behaves. These traits are Extraversion (experiencing positive emotion), Neuroticism (experiencing negative emotion), Agreeableness (considering others), Conscientiousness (following rules), and Openness/Intellect (the ability to conceptualize). By considering only these "big" traits as opposed to an entire spectrum of possible traits, scientists are consequently able to more narrowly focus on the predictors of personality (DeYoung et al. 2010). Two of these predictors are biology (nature) and the environment (nurture).

Nature vs. Nurture

If nature and nurture both play a role in determining personality, it is important to understand to what extent each of these factors contribute. One of the most practiced ways to explore this nature vs. nurture conundrum is to perform a study using identical (monozygotic) and fraternal (dizygotic) twins. One study examined the relationship between zygosity (mono- vs. di-), environment, and the prevalence of personality disorders in 221 pairs of twins. Since zygosity indicates the amount of genetic material shared between two twins (monozygotic twins share 100% of their genetic material), it would be expected that identical (monozygotic) twins

would more often share the same disorder if personality is nature-based. Likewise, if personality is nurture-based, there would be an expected relationship between environment (whether or not the twins were reared together, for example) and the prevalence of a shared disorder. The results of this study indicate that, for most of the disorders considered, biology had a strong apparent effect on personality while environment had an apparent small, albeit inconclusive effect (Torgersen et al. 2000). Similar studies yield comparable results, and this trend hasn't gone unnoticed, as illustrated in "Genes, Environment, and Personality":

> *This is now a well-replicated finding in behavior genetics, and its implications are straightforward. The similarity we see in personality between biological relatives is almost entirely genetic in origin* (Bouchard 1994).

These studies are unable to identify a consistent relationship between nurture and personality. Thus, the mechanisms underlying nature's effect on personality are what have been mesmerizing personality neuroscientists. The most direct answer to how biology might dictate personality is through the processes of the brain.

How we know the brain is responsible for personality

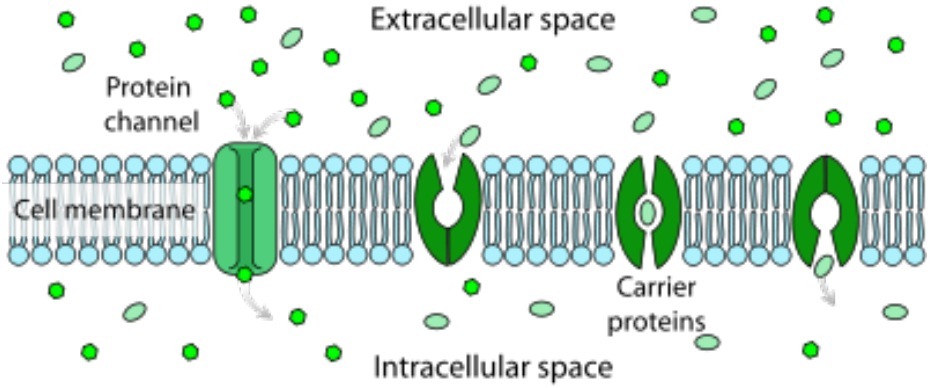
In the early 19th century, a field dedicated to understanding the relationships between brain regions and their relative functions was born. Phrenology, fathered by Franz J. Gall, focused on predicting functions of the brain by comparing individuals' personality traits with the shapes of their skulls. If several individuals shared the same trait and the same variation in the skull (an indentation, for example), it was presumed that the region of the brain beneath that part of the skull was responsible for that shared trait. Unbeknownst to Gall and others in the field, skull shape does not dictate brain shape and thus cannot attribute to the correlations that they had

established. In more recent work, however, a more compelling approach to identifying brain regions associated with personality has been taken. Dr. Colin DeYoung and his colleagues assessed the personalities of 116 healthy adults (using the "Big 5" method) and compared the traits to volume of the brain regions associated with processes related to those traits. For example, Extraversion (experiencing positive emotion) is associated with reward, so the trait Extraversion was compared to the volume of brain regions responsible for reward. For four of the five traits examined, a positive correlation was observed between the degree of a trait and the local brain volume of the structure associated with that trait. In essence, the more prominent the personality trait, the larger the related brain structure (DeYoung et al. 2010). Critics of this study and others like it claim that alternative factors contribute to brain region volume that are irrelevant of how well-developed that region is, and thus the study's conclusions drawn about relationships between the brain and personality are invalid. Despite this conflict, the data examined are interesting.

Although studies like DeYoung's are considered inconclusive, other evidence found the understanding that the brain is responsible for contributing to personality. One case report illustrates this evidence clearly; an allegedly honest and reliable man plagued with a tumor underwent its excision, and he consequently lost part of his left forebrain. After the surgery, the man exhibited uncharacteristic behaviors and was diagnosed with "acquired antisocial personality disorder" (Meyers et al. 1992). This sudden post-surgical change in character demonstrates how vital the processes of the brain are to establishing personality. What seems to be less clear, however, is the underlying mechanism within the brain that is responsible for founding an individual's thoughts, feelings, and behaviors. One possible explanation is proteins.

How proteins might be responsible for personality

Proteins are folded chains of amino acids that serve a variety of functions, including providing structural support for cells and speeding up chemical reactions. Some proteins are integrated into the membranes of cells, and neurons are no exception. The following figure illustrates what proteins embedded in a cell might look like; the blue cell membrane is riddled with green proteins that transport material back and forth across the membrane:



http://en.wikipedia.org/wiki/Membrane_transport_protein

Integral proteins in neuron membranes are responsible for delivering material in and out of the cell, especially ions. Ions are the molecules responsible for the generation of the action potential, the electrical signal with which neurons communicate. This demonstrates the importance of proteins in neuronal communication, but doesn't account for how proteins might contribute to personality.

To understand this mechanism, one study examining traumatic brain injury (TBI) in rats explored impulsive-like behavioral tendencies (changes in personality that usually occur after a TBI) and their relationship to the abundance of proteins in the cell membrane, in the damaged

brain cells. A certain protein, CHOP, is known to be expressed more in cells that are undergoing stress. Following TBI, damaged rat brain cells showed higher numbers of CHOP, as expected. When a cell stress inhibitor (preventer), called SAL, was introduced to these cells, CHOP number decreased concurrently with the decrease of impulsive-like behavior (Logsdon et al. 2014). This result suggests that the increase in CHOP expression dependent on cell stress could account for the change in personality (impulsive-like behavioral tendencies) following TBI that also occurs during cell stress. This, in concordance with the notion that proteins are fundamental to neuron firing (action potential generation), offers one possible explanation to how proteins might govern differences in thoughts, feelings, and behaviors.

If this is the case and proteins are affecting personality through their role in cell communication, the next notion to explore is how this corresponds to the claim that personality is genetic-based (Torgersen et al. 2000, Bouchard 1994). The amino acid sequences that compose proteins are arranged depending on the DNA in the cell; this means that a person's unique inherited DNA has its own unique repertoire of protein-synthesizing material. This could possibly account for variations in protein expression in different brain regions, consequently influencing personality. However, despite a plethora of evidence supporting the idea that personality is biologically-derived from proteins, many of the conclusions drawn are speculative and need to be further examined to better understand these mechanisms.

Why continue studying personality?

The current work in personality neuroscience answers some fundamental questions about how differences in individuals' thoughts, feelings, and behaviors can be accounted for. It is evident that personality is most likely influenced by protein function in the brain, but the underlying cause of that influence remains unclear. It is imperative to continue exploring these

mechanisms in order to better understand the basis of personality disorders and what contributes to differences in human personality. Any uncharacteristic thoughts, feelings, or behaviors may be considered a disorder of one's personality. Persistent personality disorders often result in other problems; according to a U.S. survey, nearly $1/10^{th}$ of the population is afflicted with a persistent disorder of the personality and, of that $1/10^{th}$, many are consequently more susceptible to problems in other aspects of their lives (Lenzenweger et al. 2007). By understanding the underlying cellular contributors to personality, scientists are likely to find ways to alleviate the associated problems with personality disorders, and possibly even the disorders themselves. Perhaps even more interestingly, the field of personality neuroscience has started to identify the possible basis for the uniqueness in thoughts, feelings, and behaviors in humans.

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