different parts of their brains. (They also use the same parts of the brain in different ways, a fact that recommends caution in the interpretation of neuroimages.) McDermott and Herrera believe that models of decision-making that more accurately reflect actual cognitive processes would produce better explanations of political phenomena.

Research blending neuroscience and genetics with political science is new and very much open to challenge. Research on cross-national genetic variation that may affect cognitive processes, and therefore comparative political behavior, has barely begun. Nevertheless, the progress reported in this symposium may motivate us to think about the political world, and ourselves, in new ways.

A Partnership Between Science and Culture

Genetic and Neurocognitive Approaches for Comparative Politics

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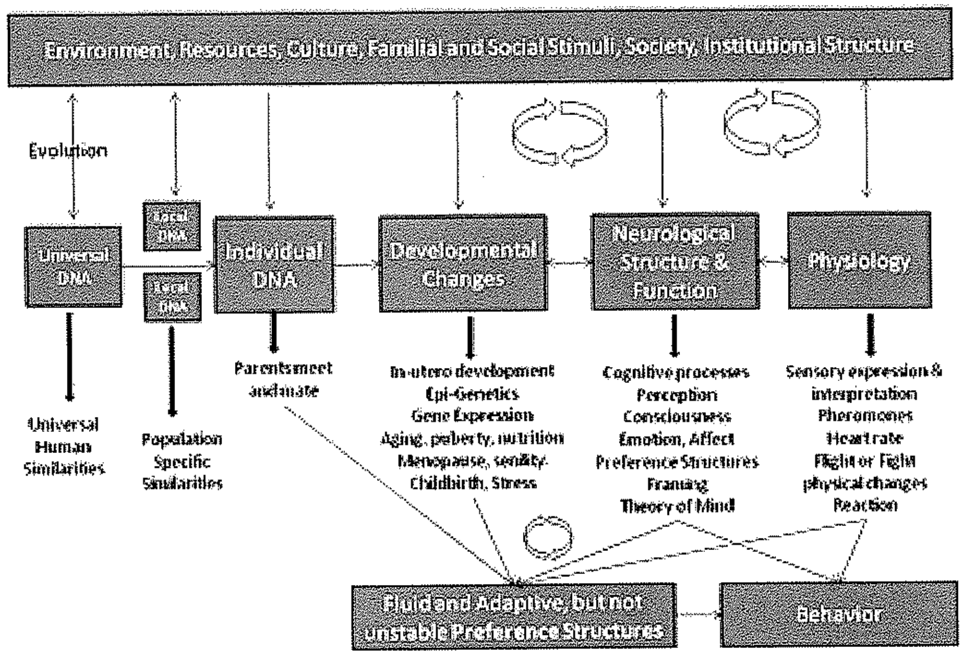
Over the last half century, theoretical and methodological advances in genetics and cognitive neuroscience have changed the way in which we understand human behavior. As the technology to identify neurological processes involved in decision making and preference formation has become widely available, cognitive, developmental, neuroscientific, and genetic approaches have emerged as the dominant paradigms in exploring behavior. Though humans are remarkably similar, we are all also unique. People's genetic structure, genetic expression, and individual physiological response to stimuli differ; moreover, people's minds are differently structured and function differently. As a result of either genes, hormones, epigenetic processes, neurology, or physiology, we are different from one another and such differences, in combination with what we experience in life are reflected in our different preferences and behaviors. Understanding the complex interaction of neurobiology and social forces is critical in gaining a more complete understanding of cognition, perception, preferences, and ultimately similarities and differences in behaviors in complex environments. The timing of this newsletter is fortuitous;[1] peruse a copy of *Science* or *Nature* to witness the social and life sciences converging in earnest. Almost all aspects of complex social behaviors are being explored with neurobiological techniques; many are directly relevant to political behaviors and the social institutions to which we focus much of our attention, such as risk propensity, social hierarchy, ideology, empathy, trust, cooperation, aggression, affiliation, leadership, punishment, and social organization.

While a paradigm shift had long occurred in most domains of the behavioral sciences, it has only recently been accepted in the main discourse of political science. However, the discipline has ventured into the forefront of this area of research. Explorations include: emotion and political decision making, familial and genetic sources of individual difference in ideology, attitudes, and voter behavior, gene by environment interactions of life events and attitudes, multivariate genetic models of personality and attitudes, genome wide explorations of ideology, hormonal differences in behavior, such as testosterone levels and political competition, different physiological reactions to threat between those with liberal and conservative orientations, different neural activations patterns across different political orientations, among many others.[2] These are just a few examples recently undertaken by political scientists, and does not include the thousands of explorations outside the discipline. There is enormous promise in cross-disciplinary communication between political scientists and those in the cognitive neurosciences.

One premise of an integrated Genetic, Developmental, Social, and Cognitive Neuroscience approach is that the questions asked by political scientists and those in the neurosciences are not independent or mutually exclusive. Rather, they serve to enrich one another. On the one hand, political scientists can use genetic and neuroscience methods to explore competing theories of psychological processes underlying various types of social and political behavior. Cognitive neuroscientific knowledge about the systems underlying memory, attention, language, emotion, perception, affect, and other processes are critical in understanding the mechanisms behind preferences and behaviors in ways not possible using expressed behaviors alone. On the other hand, genetic and neurological systems may operate differently for complex political thought, as opposed to nonsocial processes. Humans are DNA with brains and feet. We shape our world as much as the world shapes us. In order to understand behavior we must understand the context in which it is studied. Political scientists are at the very least a combination of anthropologists, economists, psychologists, sociologists, and statisticians. We know a lot about context and expressed behaviors; neurologists and geneticists know a lot about mechanisms behind decision making, and the biology behind the mechanisms. Indeed, the most interesting neurological processes to study are the most socially complex. Such a marriage has already contributed to understanding how individuals are motivated to process information in biased ways in cultural contexts, to include cultural specificity in neurological response to fearful faces,[3] stereotypes and biased attitudes,[4] cognitive dissonance,[5] and the interaction of cognition and emotion.[6]

The simple diagram above might prove useful in conceptualizing the processes of how human differences emerge, though more complex time and spatial models are widely available. Most social science training emphasizes the broad environment (e.g., socio-economic conditions and familial and cultural influences) as the primary determinant of preferences and subsequent behaviors, or takes preference as given, and focuses on self interested rational action to immediate stimuli. Such a view ignores the integration of biology and environment, as well as generational influences regarding how the environment shapes people and people in turn shape their environment. While the range of behaviors available for any species are embedded within a specific social and cultural context, (e.g., one cannot vote in a country that does not have some form of democracy), the preferences or behavior expressed within those confines is shaped by biological mechanisms and dispositions that are influenced and influence their environment over generations.

Figure 1: From Genes to Behavior: A Developmental Perspective



Starting from the left of the figure, at the most basic level, all human populations developed in a similar manner as our ancestors shared certain evolutionary selection pressures and as such we share certain Universal Similarities (e.g., all healthy humans are bipedal, have two eyes, etc.). However, more localized ancestral environments have led to slightly different developmental patterns across geographic locations (e.g., reacting to sun exposure, domestication of cattle) that are found in specific populations which have led to certain Population Specific similarities (or differences) in genetic, physiological and neurological functions (e.g., skin pigmentation, height, lactose tolerance). There is great genetic variation within populations due to a variety of factors (e.g., mate selection, in-migration, etc.). Indeed, ultimately, the most critical ancestral interaction with the environment regarding one's individual genetic disposition is the most immediate one: your parents meeting and mating. And you might be surprised to learn that with whom one mates with is incredibly relevant to their political preferences. In a mate selection study we presented spousal concordance (Table 1) on a number of socially relevant traits. It turns out that while our genes come from our parents, our parents are selecting each other on their politics, which is influenced by their genes!

Table 1: Spousal Correlations of Social and Physical Traits

Trait	Pearson's correlation	Spouse Pairs
Religiosity	0.714	4950
Political Attitudes	**0.647**	**3984**
Party Affiliation	**0.596**	**4547**
Education	0.498	4957
Height	0.227	4964
Weight	0.164	4985
Physique	0.119	5019
Neuroticism	0.082	4991
Extraversion	0.005	4739

With the incredibly rare exception, individual "genes" do not have a direct or even modest causal role in any behavior (social or otherwise). However, they are the foundational structure for the endless combination of environmental and biological stimuli that we encounter from the moment of conception to our ultimate demise. While genes as traditionally viewed do not change over one's life, their expression does. Developmental Changes through the combination of environment and biology from conception to adolescence proves to be critical to a wide array of genetic, physiological and neurological activity, which in turn leads to long-term differences in Neurological Structure and Function. Perception, cognition, attention, preferences, trust, affiliation and just about everything that makes us "human" and influences our social behavior is formed from the hormones introduced while still in the womb, to the interaction of our genetic disposition with nutrition and care at infancy to all that we experience in late adolescence throughout the remainder of our lives. Developmental changes are most dynamic in youth but are still present throughout one's life (e.g., menopause, childbirth, or simple aging). Genes are critical to the process which regulates hormones that influence neurological and cognitive function, which interacting with environmental stimuli lead to physiological changes; these changes in turn are differentially activated by specific environmental contexts and stimuli, leading to preferences and ultimately behavior. The model is not linear, but interactive, simultaneous, and recursive, with a multitude of pathways to influence any given behavior. During certain developmental and neural periods, preference or behaviors may change with a changing environment and may receive reinforcing or divergent influences from different neurological and physiological processes (e.g., hormones raging during the teens leading to intense attraction to the opposite sex might conflict with social reward or negative reinforcement mechanisms regarding norms of behavior). One may also select into, or alter, certain environments due to the interaction between environmental and physiological changes, where environmental stimuli are continually assessed and neurological processes modified.[9]

> "With the incredibly rare exception, individual "genes" do not have a direct or even modest causal role in any behavior (social or otherwise)."

But what does this approach offer for those who study different cultures and differences between cultures? As a comparativist, how and where does one start to use it? Below, I provide two examples to introduce the reader to incorporating neurocognitive approaches in understanding behaviors across cultures: one from genetics exploring difference between geographic populations and what use it might serve for political and structural differences and a second from neurology, which explores the impact of the environment on neurological function, and how such functions have long term political ramifications for certain countries and regions.

A Genetic Approach to Exploring Culture

There are approximately three billion nucleotide base pairs in the human genome.[10] Roughly 0.1-1.0% of DNA varies among individuals.[11] Jorde and Wooding[12] compared the population of three continents (Africa, Asia and Europe) and found that approximately 85-90 percent of genetic variation is found within these continental groups, and only an additional 10-15% of variation is found between them. For the most part populations are remarkably similar. However, the 10% of DNA that does appear to systematically differ between geographic populations might be of great interest to comparativists.

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One such "gene" is DRD4, which along with other genetic markers regulates the release of the biogenic hormone dopamine. Ding et al.[13] found striking differences in DRD4 frequencies among different world populations based on geographic location. This is significant for cross-regional explorations of political behaviors and institutional development as dopamine influences a wide range of neurological functions related to social behaviors, such as risk taking, reward dependence, stress reduction, attachment, fight or flight responsivity through epinephrine, cognition, personality, attention, working memory, planning, sexual attraction, visual processing, and novelty seeking.[14] The strongest relationship found between DRD4 and social behaviors is the 7R allele with attention-deficit hyperactivity disorder (ADHD).[15] While natural selection would have removed the potential of maladaptive alleles to be common in any population, it is entirely possible that some psychological traits are more adaptive in some locales and time periods even if they are undesirable in others. The 7R allele is common in South American Indians, intermediate in Europeans and Africans, and rare or nonexistent in East Asian populations. They propose that 7R bearers might

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have enjoyed a reproductive advantage in male-competitive societies where female farm systems were developed sooner, allowing the males more time for male-competition in which 7R alleles would be reproductively advantageous. ADHD today might be hyper vigilant yesterday: easily distracted behavior would not be as adaptive in environments or societies where more time was needed for food collection and survival versus that of a society where male-male posturing or competition was more encouraged. Prehistoric population differences in the development of agriculture were largely based on geographic location, which have led to slightly different genetic distributions, which have a part, however indirect or subtle, in behavior. If such differences exist, they would inevitably have long-term influences on organization, social structure, institutions, and political culture in a modern world.

In this view, social structure led to genetic population differences that in turn influence the development of future social structures, yet to date no one has explored this from a political or institutional perspective. Understanding genetic differences might help provide better means to bring about positive political, educational, and heath programs. Such an exploration might mistakenly be viewed as some form of genetic determinism, but such a view would be both naïve and counterproductive. What might be maladaptive in one format is adaptive in another. For example, children with the DRD4 allele associated with lower dopamine reception efficiency who experienced insensitive mothering or lack of social support display more externalizing problem behaviors than other children, but children with the same lower dopamine reception allele who were raised by sensitive mothers and had stronger social support showed the lowest levels of problem behavior.[16] In other words, the same genetic disposition that is correlated with higher risk in a negative environment is correlated with lower risk in a positive environment. In this view, a positive environmental change will have an even greater positive impact on certain populations. Genetic dispositions can work in many ways depending on the context. Much failure has come from "one size fits all strategies" to bring about positive societal change. Though we are often reminded about cultural differences, seldom are biological differences which emerged from cultural differences addressed in proscriptions for societal ills or simply understanding culture and the difficulty of change. We have only scratched the surface of this area of research. Along with my colleagues we found that dopamine appears to be clearly related to political preferences. In a genome wide scan, we found significant linkage signals for regions of the brain that contain glutamate, NMDA, and dopamine receptors.[17] Glutamate, by activating NMDA receptors, in part regulates dopamine release. It is a remarkable finding, in that of the thousands of regions of genes across the genome, genes related to dopamine were the most likely candidates related to individual differences in left-right world views.

"Though we are often reminded about cultural differences, seldom are biological differences which emerged from cultural differences addressed in proscriptions for societal ills or simply understanding culture and the difficulty of change."

The Environment and Neurological Function

The previous example began from an evolutionary perspective by identifying biological differences emerging from ancestral cultural and geographic differences, then considering modern behavioral differences. However, the process works in many ways. Immediate environmental differences can lead to physiological differences, which have long-term personal and societal implications. The brain is not unchanged by life experiences. Rather, socially relevant neural functions develop during childhood and this development is owed to complex interactions among genes, social and cultural environments, and children's own behavior. In a series of remarkable studies it has been shown that socioemotional deprivation and lack of warmth in infancy and childhood leads to long-term neurocognitive impairment and behavioral abnormalities, as well as attention, cognitive, emotional, empathetic and social deficits.[18] Due to economic crises in Romania in the 1980s over 65,000 children were institutionalized, many from birth, where infants spent 20 hours a day in a crib, unattended. Brain imaging provided evidence of decreased glucose metabolism in these orphan groups, leading to long-term differences in language processing, memory, and affiliative behaviors, among others listed above. A follow-up study[19] identified structural changes in brain pathways that impaired the function of the neural network that promotes communication between different brain regions which affect cognitive, emotional, learning, and behavioral function.

Additional studies provide evidence that pre- and postnatal malnutrition causes permanent brain structure and functional differences. The combination of studies provide an astonishing picture of the potential for population-based differences in neurological function when considering the reduced rates of parental care and nutrition in underdeveloped countries. By and large all human populations have an equal capacity across all domains, but being born into a underdeveloped location or during a time of famine, war, or incredible hostility, such as Somalia or the Sudan, where lack of prenatal, parental care, warmth, support, and nutrition is the norm, it seems quite likely that such forces might lead to large-scale permanent neurological changes. Decades of violence in the Gaza Strip and West Bank will have population-wide neurological implications regarding social structure, political governance, order, leadership, empathy, and just about every facet of society. In all of the comparative research I have been exposed to, while much is directed at the plight of children in underdeveloped countries, none so far have incorporated pre- and post-natal environmental factors for long-term societal implications. The understanding that it will take a multigenerational investment to overcome such ills and consequential disparities, along with a greater focus on health and welfare in youth to ensure healthy neurological development, is critical to long-term success for the overall population. Societies of individuals who, because of the social environment imposed upon them, suffer from permanent neurological deficits, cannot hope to compete, negotiate, or govern as well as societies that have lower population levels of neurological impairment. I believe this area of research, early neurological development with regard to societal support and nutrition, might be one of the most important for comparative research.

"...political scientists have been freed from traditional disciplinary constraints and the false choice of 'nature vs. nurture.'"

Due to advances in genetics and social cognitive and developmental neuroscience, political scientists have been freed from traditional disciplinary constraints and the false choice of "nature vs. nurture." There are no simplistic explanations for the complex interactions between the biological mechanisms of what it is to be human and the complex world we live in. Our bodies and brains are in continual dialogue with the environment. By embracing the complex integration of mind, body, physical environment, social relationships, institutions and large-scale social organization, comparativists can begin to undertake research on questions of interest. What are the biological and environmental contributors to risk propensity, and how do they interact with culture to dynamically produce behavior? How do hormonal levels influence social behavior, and how do social environments influence hormone levels? Do these differ either by population, institutional structure, region, or cultural practice? Which contexts, in turn, modulate gene expression? Which traits are biologically universal, which ones are not? Does knowing more about biology offer better avenues for either policy implementation, negotiation, peace, or health? What are the cognitive and emotion processing demands that support social behavior, and what cultural and country specific risks for long-term political strife are present taking into account biological considerations?

I believe it is critical that comparativists engage in this discussion, as these questions are currently being addressed outside the discipline, thereby excluding those with the in-depth cultural and geographic expertise truly necessary for such cross-disciplinary, behaviorally grounded research that offers understanding at multiple levels of analysis. The integration of science and social science favors a new model of exploring learning and development – one that embraces complexity, employs a "systems theory" approach, and openly listens to the fascinating dialogues taking place among the myriad forces of change.

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