Strategic Multilayer Assessment (SMA)

Neurobiological & Cognitive Science Insights on Radicalization and Mobilization to Violence: A Review

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TABLE OF CONTENTS

PREFACE

This concise review presents theories, findings, and techniques from the neurobiology and cognitive sciences, as well as insights from the operational community, to provide a current and comprehensive description of why individuals and groups engage in violent political behavior. This report is based primarily on recent findings from the academic community. It has been compiled with the policy, planning, and operational community as the primary audience.

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EXECUTIVE SUMMARY

Radicalization is a complex phenomenon that many different disciplines have studied. The social sciences have provided planners and operators with an understanding of the 'who', 'what', and more recently the 'why' of radicalization. The neurobiology and cognitive sciences communities are working to expand the understanding of the 'why' question. It is essential that planners and operators, who are often on the front line of counter-terrorism and counter-insurgency campaigns, have a deeper understanding of the why and how radicalization occurs. With a good understanding of the 'why' aspect of radicalization, planners, operators—and even social scientists—can avoid relying solely on purely correlative work. This report offers insights from these various fields in an easily accessible format for the operational and planning communities.

The Strategic Multilayer Assessment (SMA) team—in partnership with federal organizations (NIH, AFRL, ERDC, DOS, DARPA, etc.), industry, think tanks, and academia—has explored the concepts of radicalization and political extremism over the last several years, delving deep into analytic methods, subject matter expertise, and modeling experiments to assist military planners and operators in understanding and more effectively responding to the threat of radicalization. This review, intentionally concise, will summarize findings from previously edited volumes, conference proceedings, journal articles, and white papers produced by or for the SMA community exclusively. **It is important to note this is not a comprehensive review of all open source material(s) on the topic and as such the reader should be aware the materials presented within were prepared specifically for SMA purposes and may not address all topics or issues within the field of study**. This review presents theories, findings, and techniques from the neurobiology and cognitive sciences, as well as insights from the operational community, to provide a current and comprehensive description of why individuals and groups engage in violent political behavior. [1]

We reviewed approximately 3,000 pages of literature prepared for or by the SMA team. The full list of reviewed documents is available in Appendix a, but the core documents are listed below.[2]

- Influencing Violent Extremist Organizations Pilot Effort: Focus on Al Qaeda in the Arabian Peninsula (Fall 2011)
- Countering Violent Extremism: Scientific Methods & Strategies (September 2011)
- Neurobiology of Political Violence: New Tools, New Insights (December 2010)
- Defining a Strategic Campaign for Working with Partners to Counter and Delegitimize Violent Extremism (May 2010)
- Protecting the Homeland from International and Domestic Terrorism Threats: Current Multi-Disciplinary Perspectives on Root Causes, the Role of Ideology, and Programs for Counter-radicalization and Disengagement (January 2010)
- From the Mind to the Feet: Assessing the Perception-to-Intent-to-Action Dynamic (July 2009)

[1] SMA provides planning support to Commands with complex operational imperatives requiring multi-agency, multi-disciplinary solutions that are not within core Service/Agency competency. Solutions and participants are sought across USG and beyond. SMA is accepted and synchronized by Joint Staff/J-3/DDGO and executed by ASD (R&E)/RFD/RRTO.

[2] To request access to the SMA Website go to this URL: https://nsiteamnet/newAcct. If you already have an account and cannot recall your password, please visit this URL: https://nsiteam.net/reset. Unfortunately, users cannot automatically request their username if they have forgotten. Usernames are typically <first initial> <lastname> (e.g. achapman, scanna, etc.).

- SMA 5th Annual Conference Proceedings 29-30 November 2011 Panel on Implications of Recent Advances in Social, Cognitive & Neurobiological Science to National Security

RADICALIZATION PROCESS

THIS REVIEW IS ORGANIZED AROUND A GENERIC VISUALIZATION OF A RADICALIZATION PROCESS (SEE FIGURE 1, BELOW).

There are many models illustrating why and how radicalization occurs; however, no one model has gained significant traction in either the defense, social science, or neurobiology communities. The figure below is intentionally generic to describe radicalization in the broadest terms. There are some important caveats to consider when reviewing the illustration.

1. **The radicalization process is not linear or deterministic. An individual can regress as well as progress at any point in the cycle described below.**
2. **The unit of analysis is the individual since there are many triggers/pathways of radicalization.**
3. **The chart, particularly the opinion and action pyramids, was inspired by work done by Clark McCauly at Bryn Mawr College, but has been significantly modified by the authors of this paper.[3]**
4. **The factors that influence a person's radicalization process often cannot be as easily categorized as is done in this report. Often, a confluence of factors influences a person's radicalization pathway and it is difficult to attribute radicalization to one factor. Radicalization is a complex phenomena.**
5. **A trigger can act at any point in the opinion pyramid.**

How to Use this Document

This report is a living document that provides concise, encyclopedic-level information about advances in neurobiology that help inform how individuals become radicalized. The report distills thousands of pages of theories and research into one 50-page document. Much of the complexity, nuances, and limitations of the findings were lost in the effort to provide an easy to understand overview of the research. However, the findings and hypotheses cited are well documented and links are provided to the primary literature to allow readers to seek more detailed information.

[3] McCauly, C. (2011). The war of ideas in Yemen: Analysis of the 2011 Glevum poll. In A. Chapman & J. Adelman (Eds.) *Influencing Violent Extremist Organizations Pilot Effort: Focus on Al Qaeda in the Arabian Peninsula (AQAP).* Washington, DC: Strategic Multilayer Assessment Office, Office of the Secretary of Defense. See also Euprecht, C., Hataley, T., Moskalenko, S., & McCauley, C. (2010). Narratives and counter-narratives for global jihad: Opinion versus action. Pp. 58-71 in Eelco J.A.M. Kessels (Ed.), Countering violent extremist narratives. Breda, The Netherlands: National Coordinator for Counterterrorism and Leuprecht, C., Hataley, T., Moskalenko, S., & McCauley, C. (2010). Narratives and counter-narratives for global jihad: Opinion versus action, pp. 58-71 in Eelco J.A.M. Kessels (Ed.), Countering violent extremist narratives, Breda, The Netherlands: National Coordinator for Counterterrorism

Additionally, many of the articles, presentations, and documents contain the contact information for the primary author, and the readers of this report should feel free to contact these contributors with additional questions.

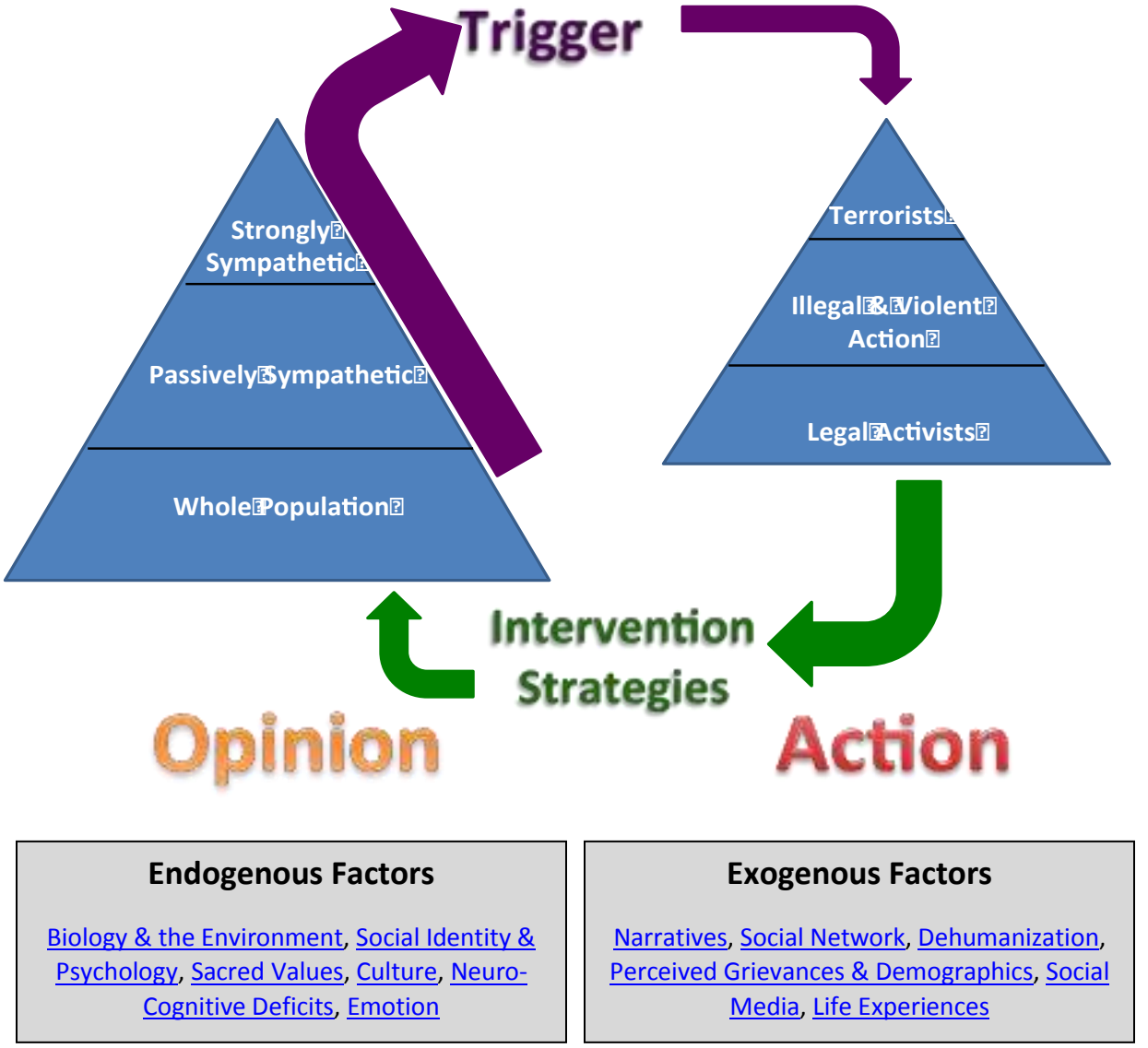

FIGURE 1. A CONCEPTUAL FRAMEWORK OF RADICALIZATION PROCESS

This model is a framework and a simple way to understand the radicalization process. An individual can move through the stages in a non-liner way between the pyramids. The research suggests that a trigger is necessary to move an individual from the opinion pyramid to the action pyramid. Intervention strategies are used to move an individual from the action pyramid to the opinion pyramid. Additionally, a trigger can act at any point in the opinion pyramid.

THE PROCESS OF RADICALIZATION

Opinion Pyramid

- Whole Population: entire population of interest, the vast majority of whom choose to not engage in violence
- Passive Sympathizers: subset of the population whose values, beliefs, etc., generally align with the values and objectives of the radical group but who do not take any action to support the group
- Active Sympathizers: subset of passive sympathizers that strongly associate with radical group identity, ideology, etc., but who do not actively support violence or belong to the radical group

Trigger/Action Threshold

- Trigger: an event, shock, person, violence, threat to sacred values, etc., that convinces a person to take *action* to change the status quo

Action Pyramid

- Legal Activists: individuals who decide to join a group and participate in legal, non-violent protest
- Illegal Activists: individuals who decide to provide illicit advice, financing, planning, or participation in illegal actions (violent or non-violent)
- Violent Actors: individuals who participate in (doing, planning, financing) illegal, violent acts of terrorism

Intervention Strategies

- Intervention Strategies are actions taken by governments or organizations to *mitigate* political violence as well as to encourage those embarking on the radicalization pathway to *turn away* from political violence.

RADICALIZATION FACTORS

In this generic illustration of radicalization (Figure 1), we break down the factors that influence an individual's decision to radicalize into two sets of factors: *endogenous* and *exogenous*. While these terms are most commonly used to describe variables in a model, the radicalization pathway described above **is not a model.** In this context, *endogenous factors* refer to a person's inherent characteristics that cannot easily be changed including genetics, culture, environment, values, and emotions. These characteristics are often necessary, but not sufficient, to cause a person to take violent action. They are represented on the left side of Figure 1 as part of the Opinion Pyramid. *Exogenous factors* are external influences on a person that are not inherent to one's personality, culture, genetics, etc. These factors are often triggers that move a predisposed person to take action. Exogenous influences include exposure to narratives, radical social networks, perceived grievances, and traumatic life experiences. Exogenous variables are represented on the right side of the chart under the Action Pyramid.

ENDOGENOUS VARIABLES

Research on identity shows that individuals join groups to develop their sense of identity, significance, and purpose. As social beings, humans crave membership in groups, and when we do, we derive great satisfaction from adhering to the group's specific rules and implicit norms. Furthermore, people who identify strongly with a group and have strong biases against an out-

group are more likely to behave aggressively towards others in an effort to protect their in-group and sense of identity. This is why the development of strong in-group/out-group differentiation contributes to tension and violence between groups.

Challenging a person's sacred values often entrench a particular belief and cause a person to push back against the perceived threat. Sacred values are the core tenets a person refuses to sell or compromise. They are often held in common by a population or a subset of a population and define a population's belief in what the world should be like. Sacred values, like attitudes, are not malleable and are not easily changed.

Culture can influence a person's predisposition to sympathize with a radical group. A person's culture influences a person's behavior and brain function. Exposure to radical beliefs and materials increases a person's risk of radicalization. Common facets of culture, such as music, poetry, and television shows, also have the potential to influence attitudes, social norms, and even behavior.[4]

An individual's biology and environment may greatly influence a person's propensity towards radicalization. Drawing from evolutionary biology and psychology, scientists discuss the importance of various factors in influencing a person's radicalization including inclusive fitness (i.e., enhancing the chances of gene replication), genetic predisposition toward attitudes, and environmental influences on attitudes and beliefs. Additionally, while most violent extremists are mentally sound, neurocognitive imbalances make some individuals prone towards aggression and violence.

Emotion plays a role in the promulgation of violence. Emotion evolves from information processing systems that aid in survival. They are the immediate reactions to events surrounding an individual and act as a filter for understanding and responding to one's environment. Emotions are one of the major sources of motivation for behavior.

EXOGENOUS VARIABLES

Narratives can alter a person's beliefs, attitudes, and intentions; they help frame the world in which an individual lives. Additionally, they provide an alternate form of rationality and simplify complex mental tasks that may lead a person to yield to persuasive calls to action. Extremist groups are very good at using narratives to persuade potential recruits that they have a moral imperative to join the cause.

Social networks have been shown to be a critical component of an individual's radicalization process: people who spend time together influence each other. Various studies from across the fields of psychology, neuroscience, and sociology have highlighted the importance that a person's social network plays in influencing a person to embrace political violence.

Dehumanization is a mental process that rationalizes the use "violent or degrading acts…not typically reserved for people" against an individual or group. It reduces an individual's worth to the level of animals or machines. Dehumanized subjects are perceived as not worthy of human emotions such as empathy, reinforcing their degraded status. This process of dehumanization of the other is an important step in an individual's radicalization: it allows a person to rationalize committing violence against others.

[4] See also Ortiz and Harwood discussion of culture and intergroup perceptions.

While social media, such as Facebook, chat rooms, Twitter, etc., does not cause radicalization, it serves as a forum to facilitate the spread of radicalizing and evocative messages. Dramatic events, when reported through social media, have the potential to transform ideas into realities in ways that inflame the passions of a targeted audience. This new form of media has the potential to act as an "echo chamber" for an individual's radical ideology and actually reinforce and further radicalize the individual.

Life experiences also influence a person's likelihood of supporting violent extremism. Some experiences are tangible factors—a history of violence, competition over scarce resources, etc.—that can drive people toward political violence. Other examples of life experiences include military service, level of education, and sexual deprivation. Although these experiences do not fit into one specific theory, they influence an individual and are significant in the decision-making and radicalization process.

Over the last several decades, many researchers have blamed demographic factors (like poverty) and perceived grievances (like discrimination) for pushing some individuals towards radicalization. However, people in similar environments often have radically different political views and only a relatively small number of people choose violence. Therefore, it is not *solely* demographics that radicalize an individual: "the fact remains some people in a given environment engage in violence but most do not" so "something else combines with their strong beliefs to lead them to commit violence.

TRIGGERS

A trigger is an event, shock, person, violence, or threat that convinces a person to take action to change the status quo. There is very little literature that describes, on the group level, the discreet event(s) that compel people to participate in political violence, which may be due to the unique way that events and experiences (exogenous factors) act upon a person's predisposition to violence (endogenous factors). It was our hope and expectation that the literature would reveal universal triggers (like exposure to violence, blatant discrimination, etc.) that compel people to take violence action, but no such universal triggers were discussed. Instead, the research reveals insights about triggers specific to the types of factors that influence a person's predisposition towards violence. These triggers are described for each factor where available.

STRATEGIC INTERVENTIONS

Likewise, the review did not reveal universally effective strategic interventions that cause individuals or groups to regress along the radicalization pathway. However, interventions specific to each endogenous or exogenous factor are described (as available) within each factor write up.

BACKGROUND

This review summarizes previously edited volumes, conference proceedings, and white papers produced by the SMA community on top theories and hypotheses behind radicalization and decisions to engage in political extremism. The review highlights theories, findings, and techniques from the neuroscience community to provide insight into the biological, environmental, and genetic influences on an individual's radicalization pathway. Included is a short primer on the basics of neurobiology, which is intended to assist in placing recent neurobiological findings in the most

relevant context for rapid understanding by the operational community. The review's intention is to help military operators, analysts, planners, and decision makers to understand why individuals and groups engage in violent behavior.

This review is limited in that:

- it presents complex findings and hypotheses in short summaries;
- it only represents material produced by or for the SMA team and is not intended to be a comprehensive summary of all neurobiology research relating to violence; and
- the field of neurobiology is relatively young and many findings are not intended to be applied specifically to national security issues.

Some of the more common theories and depictions regarding radicalization include the following

- Conveyor belt theory: radicalization is a deterministic pathway that begins with joining and participating in the community and ends with engagement in violence
- Slippery slope: similar to the conveyor belt theory, the slippery slope suggests that once one begins to associate with a particular group and becomes enmeshed in an increasingly restricted social network, radicalization is the most likely outcome
- Pyramid Model: individuals are grouped by their commitment to a cause and classified in an opinion or action pyramid. Suggests that there are different levels of radicalization throughout the population.
- Conflict Zone Theory: individuals living inside a conflict zone are radicalized for different reasons than those outside conflict zones. Radicalization inside conflict zones stems from factors such as personal traumatization and desire for revenge while outside conflict zones it stems from dire poverty, frustrated aspirations, and exposure to traumatic experiences of other's *inside* conflict zones to bring the conflict into a non conflict zone.

Findings from the neurobiology community may often be challenging for the military analyst, planner, and decision maker to access for various reasons.

- The neurobiology of behavior is a relatively new field
- Neurobiology research is primarily conducted within a controlled lab setting and while insights can be generalized the research findings are often narrow in scope.
- Neurobiology findings are not often directly applied to issues of national security
- Neurobiology scientific literature may not be easily accessible to tease out relevant findings.
- Unfamiliarity with social science theories, including:
    - Expected utility theory
    - Rational actor theory
    - Maslow's hierarchy of needs
    - Prospect theory
    - Behavioral game theory

However, neurobiology findings can augment understanding of political violence gained through social science research or personal experience. Related to this, neurocognitive research has been identified as a field of opportunity for national security and national defense (Committee on military and intelligence methodology for emergent neurophysiological and cognitive/neural reserach in the next two decades, National research council of the national academies, 2008) (Committee on opportunities in neuroscience for future army applications, National research

council of the national academies, 2009). It can be expected that as this field of endeavor expands, much will be of utility to our understanding of the social aspects of violent extremism/radicalism. Some would argue that without an understanding of the biological basis of decision-making and motivation, the social sciences are restricted to correlative work, which is useful, but can only take one so far. Others suggest that neuroscience is on the brink of helping decision makers distinguish between the intended, stated, and actual behaviors of an individual or group's behaviors. More subtle and effective policies and plans can be crafted using multidisciplinary approaches.

INTRODUCTION TO NEUROBIOLOGY

Adapted from Jeanette Norden, Diane DiEuliis, Abigail Chapman, and Tessa Baker

The brain is often considered the most extraordinary organ in the human body. Everything a human being does or thinks or feels is the result of brain cell activity, which is then transmitted via other neural networks throughout the body. For decades neuroscientists have been devoted to understanding the complex biology of neurons and their interconnections that underlie the broad scope of human actions and behavior.

The brain controls all aspects of the human body—from involuntary, or autonomic activities that do not require conscious thought, to voluntary purposeful movement of the body itself, to the highest level thought processes, conceptualization and decision-making functions. For example, the brain stem is involved in very basic involuntary processes like breathing, blinking, and heart rate. But, what separates human beings from other animals is the development of the large hemispheres of the cerebrum, and especially the outermost layers, or cortex, which control the highest order thinking and functions of the brain.

The field of neurobiology is focused on understanding how brain cells connect, fire, and control all innervated function in the body. Our highly developed brain, and especially the prefrontal cortex, is at the center of who and what we are—it is what distinguishes us from other mammals and it is the essence of our very being. It has only been in the past decade, however, that scientists have recognized the interconnections between the anatomy and physiology of the brain, our awareness of self (psychology), and our interactions with the world and people around us (sociology and political science). Applying the tools of these various disciplines in tandem with neurobiology allows researchers to gain deeper insight into understanding intentions and motivations by capitalizing on multi-method approaches to studying various phenomena.

To understand how the brain controls thought and behavior, and subsequently, how individuals relate in societies, requires a neurobiological understanding of how the brain works at the physical level, and attempting to map that to behavioral dynamics observed in individuals, groups, or societies. As noted above, many social science studies from decades past have been relegated to correlative studies, surveys, observational studies, or aggregated metadata analyses of preexisting data sets. While these studies have the advantage of providing contextual detail on attitudes, behaviors, and motivations in the desired environment, they can be fraught with confounds and causality can be difficult to establish. With recent advances in technology within the neurosciences, such as innovative imaging, the mapping of particular genes across brain functions and regions, and the rapid advances in cognitive neuroscience, there is now unprecedented opportunity to attempt to correlate fundamental neurobiological brain functions to human cognitive behavior, and use this

knowledge to augment social science studies. It is from this perspective that we would hope to understand radicalism or other violent behaviors.

Neurobiology: The Secret Life of the Neuron

This section of the primer is designed to introduce you to common neurobiological terms, anatomy, and concepts, while providing an understanding of how neurobiological substrates and structures are involved in behaviors such as fear, social support, aggression, and violence. We endeavor here to provide sufficient breadth of the topic to expose readers to many concepts and terms, in order to facilitate casual readers' understanding of the discussion in this report.

The primary unit of the cell and its constituent parts are the building blocks of biological organisms. Cells provide the fundamental activities that drive living systems such as generating energy, processing proteins, disposing of waste materials, etc. The brain consists of neurons, the fundamental nerve cell, and glial cells. Glia are often referred to as "supporting" cells, that nourish, protect, and facilitate neuron function, although increasing evidence suggests that glia may play active roles in information processing. Neurons are polarized cells that have the ability to generate electrochemical impulses which travel from one neuron to the next, the summation of which culminate in the brain activity that leads to actions and thoughts.

At the core of the adult human brain's ability to sense, to think, and to control basic bodily functions, are approximately 100 billion neurons that create the complex circuitry of the brain as well as the nerves dispersed throughout the body. Neurons, whose cell processes (axons) can be up to a meter (3.3 feet) long in the spinal column, are the fundamental unit of brain and nervous system function—sending and receiving millions of signals every day. Signals are received by a fingerlike network (*dendrites*), processed by the cell's center body (*soma*) and then transmitted to the next neuron via an axon.

Neurons meet at a *synapse*, which is the junction between the axon of one neuron and the dendrites of the next neuron. The separation between the axon and dendrites is a microscopic (20-40 nm) gap, or *synaptic cleft,* into which *neurotransmitters,* or signaling molecules, are released. Synaptic transmission involves the receipt of a signal by dendrites, which results in the electrochemical changes, either *depolarization* or *hyperpolarization*, of membrane of the dendrites; the sum of all the activity onto the dendrites and the cell body of the neuron may then produce an action potential or electrical signal which is propagated down the axon. That axon releases a neurotransmitter that affects the next cell's dendrites and the signal is propagated along the neural network. The entire cascade of signal receipt, depolarization, and neurotransmitter release takes approximately 1 millisecond (one 1/thousandth of a second).

Neurotransmitters may be amino acids, peptides, or other molecules. A transmitter might act primarily as an excitatory agent—strengthening a signal—while at other synapses a transmitter may play an inhibitory role—weakening a signal. Evidence is growing that certain specific neurotransmitters are especially strongly associated with specific aspects of emotion or cognition. The neurotransmitter serotonin, for example, is linked to feelings of wellbeing with deficiencies associated with depression. Dopamine has been linked to gambling and addictive behaviors, while oxytocin has been found to stimulate trust. For details on neurotransmitters and their associated functions, see Appendix C.

Neurobiology: Brain Structures

If we look beyond the individual behavior of neurons and their chemical signaling molecules, to the larger neural network, it is important to focus on those specialized areas of the brain that might underlie or play a role in particular thought processes and behaviors believed to operate in radicalism or other behaviors. As noted previously, the development of the front part of the brain, specifically the prefrontal cortex, is what distinguishes human beings from all other mammals. Areas of the frontal cortex appear to be critically involved in social relations and matching events with emotions. The *frontal cortex* is the receiving "processor" for a myriad of signals generated by many parts of the brain; these areas are involved in weighing cognitive and emotional factors in arriving at decisions.

So where are emotional signals coming from? The *limbic system* is a set of brain structures that control learning and memory, emotion, and influence executive function (this latter term refers to cognitive processes such as planning, working memory, attention, problem solving, and verbal reasoning.) Areas of the prefrontal cortex, for example, are specifically capable of abstracting morals from what a human being has been exposed to within their families or culture. The hippocampus, which is also a limbic system structure, is specifically wired for learning and memory.

Below the temporal cortex lies another important limbic system structure called the amygdala. This area of the brain is wired to respond to threats in the environment. When a threat is perceived by these neurons, through sensory or other inputs, the resultant neuronal firing can result in one of several options—the so-called "flight, fight, or freeze" response. The individual can flee and attempt to avoid the threat, and neurons will fire to enable those complex movements, the individual can stand and fight the threat, engaging a different set of neurons related to those physical actions, or freeze when the brain is analyzing the situation and attempting to avoid further detection. As brain structure evolved over time in humans. This "fight, flight, or freeze" response likely enabled survival in hostile environments encountered early in our evolution. In modern society, while a bear or tiger may rarely threaten a human being, the amygdala still possesses the full ability to engage "fight, flight, or freeze" responses; something physically threatening is not fully distinguished by the amygdala from something psychologically threatening. The "fight, flight, or freeze" response, as part of a hyperaroused state, may shut down higher cognitive function, so in the modern day setting this can have ramifications for and individual's response to non-physical threats. The "fight, flight, or freeze" response can occur when triggered by external events, including environmental or ecological pressures, intergroup or interpersonal conflict, or in the world that appear novel or ambiguous. When this "fight, flight, or freeze" response is constantly active in a threating environment over long periods of time, an individual can develop the syndrome called post-traumatic stress disorder (PTSD). PTSD has symptoms of nervousness, distress, depression, or exaggerated responses to non-threatening stimuli. It can be observed in the war fighter who has been in the field for extended periods of time, in victims of rape or physical abuse, and even in victims of car accidents or other disaster scenarios. Understanding the neurobiological basis of syndromes like PTSD can be extremely helpful for understanding a variety of related human behaviors.

Neurobiology: Neurogenetics

Underlying all neuronal and brain structure function are genes. Genes are composed of DNA and each and every cell of the human body contains an identical set of genes inherited from one's

parents. Genes provide the blueprint for all the proteins, neurotransmitters, cellular structures, etc. expressed by neurons, the study of which is called Neurogenetics. Scientists are just beginning to map gene expression to particular areas of the brain, and are attempting to learn which complements of different genes may contribute to aspects of brain function.

A simpler statement is that individual neurons express particular genes based on their function. So, for example, specific neurons may express particular neurotransmitters like serotonin, an important signaling molecule in the brain. If an individual has inherited a genotype that does not allow for enough production of serotonin, that individual *may* be predisposed to clinical depression. Similarly, if the individual is exposed to an environmental factor that suppresses the gene for serotonin, the same result *may* occur; the person can suffer from depression based on that particular environmental "trigger". It is important to recognize that a genetic predisposition does not always culminate in that particular trait it is linked to.

Understanding the complex factors of inheritance and environmental triggers that control genetic expression is important to our understanding of basic brain function and behavior. When trying to relate specific genes to behaviors, the scenario is even more complex, as single genes are not responsible for complex behavioral traits, rather it includes a collection of genes, learned neuronal signaling over time, the added factors of environment, cultural influences, and potential other factors as yet not identified. As genes create proteins and cellular components, these molecules can then signal back and turn their parent genes on and off accordingly as part of complex feedback loops based on expression. And some genes' sole function is to regulate other genes. It is not fully understood how neuronal activity in the context of emotions and through processes affect these complex genetic controls. Taking these facts into consideration, the nascent field of neurogenetics should be recognized as another tool in examining all the complex factors that contribute to how and why an individual perceives events in the environment in a given manner. While genetics is not deterministic, it is important to understand as the basic unit of cellular control. (For further discussion and examples see appendix C)

RADICALIZATION

It is important to note that the factors that influence a person's radicalization trajectory often cannot be as easily categorized as is done in this report. Often, a confluence of factors influences a person's radicalization pathway and it is difficult to attribute radicalization to one factor. However, for ease of use and discussion, the factors are distinctly grouped and defined in this report. This report is intended to be a living document that will be updated as new insights emerge. Many of the articles, presentations, and documents contain the contact information for the primary author, and the readers of this report should feel free to contact these contributors with additional questions.

ENDOGENOUS FACTORS

Endogenous factors refer to a person's inherent characteristics that cannot easily be changed including genetics, culture, environment, values, and emotions. These characteristics are often necessary, but not sufficient, to cause a person to take violent action. They are represented on the left side of Figure 1 as part of the Opinion Pyramid.

BIOLOGY & THE ENVIRONMENT

One's biology and environment may greatly influence a person's propensity towards radicalization. Drawing from evolutionary biology and psychology, many factors influence a person's radicalization trajectory including sacred values, inclusive fitness (i.e., enhancing the chances of gene replication), genetic predisposition toward attitudes, and environmental influences on attitudes and beliefs (Chapman & Adelman, 2011, pp. 11-12). While the view that genetic and biological factors can profoundly influence political attitudes is controversial, there is some preliminary evidence in support of the notion that biology can influence politics in predictable and systematic ways (Hatemi, McDermott, & Stenner, 2011, p. 205).

Findings

Evolutionary Neurobiology (ENB) Theory[5] posits that "animals have evolved to behave in ways that favor the transmission of their genes" (Victoroff, 2011, p. 95). So why then do individuals, particularly young men, engage in political violence with its relatively higher risk of mortality? One potential answer according to ENB theory is that **individuals participate in political violence to maximize their inclusive fitness**. "An organism is fitter if it can transmit more copies of its genes either directly (through having offspring) or indirectly (through non-descendent relatives)" (p. 98). Participation in political violence could increase a person's direct fitness by making him seem more appealing—more dashing, daring, etc. An individual may also participate in political violence to increase his indirect fitness by accruing benefits to his family (as is the case in the financial compensation/reward to families of suicide bombers) or as a way to obtain a regular paycheck. However, one serious limitation of the ability of ENB theory to predict behavior is that an individual's brain bases its decisions on the *perception* of fitness and perception varies greatly between individuals (p. 99).

Living life "fast" maximizes one's inclusive fitness. One component of ENB theory states that an individual's life history strategy (LHS) divides animals into two types: fast-living (Victoroff, 2011, p. 102)-with-many offspring (r-selected LHS) and slow-living-with-fewer-offspring (K-selected LHS) (p. 102). Strong evidence suggests that human temperament is characterized by a variation in LHS with fast-r versus slow-K oriented individuals. Both genetic and environmental factors determine the direction people take at this fork in the road. LHS is somewhat inheritable but early life experience plays a role with factors such as stress, paternal absence, parental divorce, family conflict, and insecurity predicting faster LHS (Victoroff, 2011, p. 102). Both the fast and slow LHS fit within the core hypothesis of ENB—that people act to maximize their inclusive fitness, although there are many ways to achieve fitness. The allure of violent extremism is similar to the allure of gang delinquency—a risky, promiscuous LHS that serves to broadcast physical vitality, courage, and altruistic group commitment and to enhance male attractiveness to women and potentially promote promiscuous production of offspring (p. 103). However, this interpretation alone would be over simplistic.

[5]"The science of analyzing motivation and predicting behavior based on ENB theory is in its infancy. No evidence exists that, to date, such an analysis has enhanced the predictive power of policy makers or increased the efficacy of any socio-political policy or military strategy" (Victoroff, 2011, p. 92). In sufficient empirical research has been done (p. 97).

Individuals may sacrifice themselves for a cause that promotes the perceived wellbeing of their in-group. Why would an individual turn to political violence when he or she has not been personally wronged? Part of the answer may be due to the concept of altruism. Victoroff describes altruism as a "superficially self-defeating behavior that reduces the fitness of one individual in order to increase the fitness of another" (Victoroff, 2011, p. 103). The case of intrafamilial altruism is easy to understand where one person sacrifices for the benefit of genetically linked family members. However, altruism towards non-kin is harder to explain (p.104). Some explanations include reciprocal altruism where one sacrifices for a non-kin member or group with the expectation that the favor will be returned. Additionally, the concept fictive kin is a form of reciprocal altruism where one sacrifices for a group one perceives to be as important for one's fitness as true kin (p. 105).

One hypothesis that has not been tested or fully researched is that **those who join terrorist groups are especially prone to the psychology of antisocial punishment** (Victoroff, 2011, pp. 107-108). Antisocial punishment is characterized as a society's tendency to harshly punish non-cooperators even when the cost to the punisher seems to outweigh any benefit.

So far, no clear genetic marker of social or political traits (including receptivity to values like freedom and diversity) have been found (Hatemi, McDermott, & Stenner, 2011, p. 179). However, it is believed that these **traits rest on a particular psychological disposition, which is formed by the environment's interaction with one's genes through epigenetic mechanism**s (e.g., how the environment and one's choices affect one's genetic code) (pp. 179, 195-6). The *World Values Survey* shows that support for the liberal values necessary for a western liberal democracy to function are not evenly distributed across the world, but rather remain absent in precisely the locations that are most at risk for terrorist recruitment (p. 193). Tolerance is not a function of the type of governance one has, but on one's psychological disposition.

Political participation is a factor not only of one's experiences and preferences, but also of his/her physiological orientation. People have different physiological orientations (Grusczynsyki, 2010). If a person's physiological responsiveness is minimal, the predisposition towards action will also be diminished, ceterus paribus. A person's physiological response is influenced by subconscious factors such as emotionally laden interpersonal interactions (p. 6).

Flawed Assumptions

Flawed assumptions (Hatemi, McDermott, & Stenner, 2011, p. 194) have been widely incorporated into the policy and planning communities perhaps, in part, because it runs counter to the principles of most of the social sciences. In particular, two assumptions espoused by the social science community run counter to findings in the cognitive sciences.

- Attitudes can be changed because they are environmentally determined and therefore subject to situational and circumstantial forces.
- Transmission of values occurs exclusively through social and cultural mechanisms and that biological and genetic components had no part to play in their formation.

Indicators

- Degree of societal and individual intolerance (or lack thereof) may indicate that an individual or population may react aggressively to actions perceived to challenge closely held, genetically informed values (Hatemi, McDermott, & Stenner, 2011).
- In attempting to predict an individual's level of participation in the political process, mean levels of electrodermal change in response to varied but not-political stimuli is an extremely useful variable, perhaps more useful than tradition demographic and personality variables. (Grusczynsyki, 2010)

Triggers

- According to Dr. Victoroff, Al Qaeda in the Arabian Peninsula (AQAP) has effectively utilized the modern tools of communication such as the Internet to trumpet the reputation of itself and its members. It does so ostensibly to persuade potential supporters or recruits, but also because this tactic rewards its members, enhances their reputation, and ultimately advances its inclusive fitness prospects (Victoroff, 2011, p. 106).

Intervention Strategies

- Because values are partially genetically informed and not easily malleable, democracy promotion strategies (or any strategy to change values) must either include generations of commitments, like was seen in Germany and Japan, or remain largely unsuccessful (Hatemi, McDermott, & Stenner, 2011, p. 179).
- "Efforts to prevent individuals and groups from taking violent/extremist action once they are committed tend to be costly and of limited effectiveness. There is no evidence that it is possible to recondition these terrorists. We could be far more effective at prophylaxis, however, by encouraging those more disposed towards violence, once provoked, to change targets by removing the inspiration to act violence against the U.S. The USG can change the source of terrorists' motivation and their targets" (Hatemi, McDermott, & Stenner, 2011, p. 206).

SOCIAL IDENTITY & PSYCHOLOGY

Social identities represent group memberships that are important or have value for individuals. In this way, they provide a framework for understanding oneself, others, and the world one lives in (Chapman & Adelman, 2011, pp. 10-11). Long-lasting cultural narratives and social identities tap into the same notion of how people make sense of the world given a group's shared history, rituals, and values. At the same time, narratives and social identities are social constructs—driven by both society and the individuals who incorporate them. In addition, social identities are dynamic. In other words, social identities shift with the context of the situation and are dependent upon the groups that are most relevant or salient to the situation. What is more, they are intensely personal, yet wildly collective; they shape the way society uses symbols and other group identifiers, yet are also shaped by those same symbols and identifiers.

Within the discussion of social identity, an understanding of norms begins to take shape (Chapman & Adelman, 2011, pp. 10-11). Not only how norms emerge from the groups that we are a part of, both from our group's narratives and our interactions, but also how norms foster the ability to join violent groups or support violent actions. What is more, leaders who can create and spread norms through their groups are most effective at bringing about the change they strive for. As described by

several academics, successful leaders who are identity entrepreneurs by representing the group are also able to shape the way the group thinks of itself. Good leaders do this by spreading norms in a non-coercive way.

Findings

Social identities become stronger in times of uncertainty (Chapman & Adelman, 2011, pp. 10-11). Researchers hypothesize that individuals also join groups to boost their self-esteem, to minimize their fear about death, or to reduce the fear of uncertainties in the world around them (Adelman & Chapman, 2011, p. 17). In fact, when people feel more uncertain, they look to those groups that are cohesive with clear guidelines and norms, sticking more closely to group social norms, and even adhering to more extreme group norms. This can also be described as the "false polarization effect" where people artificially exaggerate the ideological differences between themselves and those of their out-group/opponent (Bruneau, 2010, p. 24). The greater the disagreement, the more likely one is to assume that the other person is biased and irrational, and the more likely we are to advocate conflict with the other rather than engage in conciliatory gestures.

People may be more willing to follow a representative leader in times of uncertainty, regardless of the potential outcome (Chapman & Adelman, 2011, pp. 10-11). Social identity is the tie between leaders and followers (Adelman & Chapman, 2011, pp. 13, 25). There are four main characteristics of an effective leader: he/she (1) is the quintessential in-group prototype, (2) appears to be working for the group instead of for personal gain, (3) is able to shape the way the group thinks of itself, and (4) is able to embed shared identity in institutions and rituals. Biological variance may help explain how leaders are different from the general population (McDermott, 2010, pp. 53-54). For example, biological and gene difference may incite different responses in leaders than in followers. Hormonal markers, like serotonin (which regulates mood, anger, aggression, and appetite), may be different in leaders. In a look at radicalization in U.S. prisons, the most important factor in an individual's decision to radicalize was inmate leadership—particularly one-on-one interactions with charismatic leaders (Hamm, Prisoner radicalization and sacred terrorism, 2011, pp. 15, 17-18).

Powerful leaders set the tone for groups to interpret or reinterpret events in certain ways that then lead to group emotions. Leaders do this by creating stories based on their appraisals or reappraisals of critical events and situations by communicating the emotions associated with their reappraised stories to their followers and subordinates. This communication occurs through specific types of emotion-laden words, metaphors, images, and analogies, as well as nonverbally through their faces, voices, gestures, and body language. Through careful use of language and nonverbal behaviors**, leaders are in a position to motivate, escalate, or defuse situations and incite action, or not, through emotion**.

Uniting against a common enemy is one way to foster support for a cause. It is intuitively understood that one tends to favor "our" group over "their" group (Adelman & Chapman, 2011, p. 15). Therefore, when the USG takes action, it must ensure that the action does not unify different groups together against a common enemy (pp. 10-11). Good leaders are able to project a common enemy that serves to unite the group, whether the enemy is factual or not (p. 29).

People join groups to develop their sense of identity, significance, and purpose (Adelman & Chapman, 2011, p. 15)**.** Organizations that speak to an individual's sense of identity and group

belongingness help shape subsequent loyalty to the group (Adelman & Chapman, 2011, p. 13). Individuals form alliances, bonds, and connections to similar others who share similar worldviews and beliefs. Furthermore, some argue that people follow cultural dictates not only because they generate personal utility, but also because through "doing" (or "consuming") they "become" somebody (Gupta, 2011, p. 49). It helps one establish his/her identity as a member of his/her chosen group.

Belonging to a group is associated with greater liking and favoritism toward other group members (whether they have met in person or not) (Adelman & Chapman, 2011, p. 13; Chiao, Cultural neuroscience of intergroup relations, 2010, pp. 22-23) In-group favoritism and out-group derogation leads to the attribution of more human characteristics including emotions, towards in-group members compared to out-groups (Matsumoto, Hwang, & Frank, 2010, p. 4). Additionally, altruistic behavior for fellow group members comes naturally. This is in large part due to inclusive fitness that, for humans, is not based on genetics, like most other species (Gupta, Understanding terrorism and political violence: the life cycle birth, growth, transformation, and demise, 2008).

Protecting social identities is a necessary but not sufficient reason for a person to engage in political violence (Adelman & Chapman, 2011, p. 18)**.** Other factors or triggers are required before violence is utilized.

Individuals crave to belong to groups, and when one does, one derives great satisfaction by adhering to their explicit rules and implicit norms (Gupta, 2011, pp. 47-48). Additionally, the more prototypical one is of his or her group, the more positively the individual will be rated and trusted by group members (Adelman & Chapman, 2011, p. 21). Upholding the prototype by adhering to violent or extreme group norms may be vital to terrorist groups' enduring community support. Furthermore, uncertainty leads a person to adhere more strongly to a group's norms, making the person a more prototypical group member (p. 23).

The various factors that motivate one to commit acts of political violence, particularly suicide attacks, may be understood using the framework of a quest for significance (Kruglanski, Chen, Dechesne, Fishman, & Orehek, 2009, p. 331). No matter the trigger (personal—trauma, humiliation, social exclusion; ideological—liberation from foreign occupation, defense of one's nation or religion; or social pressures), individuals commit acts of terrorism to either restore personal significance, gain personal significance, or to prevent the loss of significance. One's culture establishes the thresholds for being a "good" member of society (p. 335-36). Supreme goodness is often defined as sacrificing oneself for the group—these people are heroes. Heroes live on in the memory of one's group, granting the hero an element of immortality.

Indicators

- The existence of a minority group in a large country with a strong ethnic identity often coincides with religious differences and conflict (Gupta, 2011, pp. 48-49). For example, the Catholic minority in Northern Ireland, the Hindu minority in Buddhist Sri Lanka, or the Sikh minority in Hindu India are cases where religion and national aspirations are closely intertwined.
- On the state level, states with strong heterogeneous group identities that also have the resources to mobilize are the most likely to experience political violence (Casebeer W. , 2011, p. 70). This relationship between group identities and resources is captured by the At-Risk Group Identity classification scheme produced by Dr. William Casebeer at DARPA.

- Violence may also erupt in states that have histories and experiences that make it likely that groups would self-consciously attempt to emphasize in-group/out group distinctions (this can be seen in places where colonial powers attempted to set up proxy groups that vied for power), where groups of people were forced to share a common fate, where certain markers of identity become especially salient, and where social forces are at work to actively construct and reinforce identity every day (Casebeer W. , 2011, p. 71).
- Many people may sympathize or even become active supporters of a Violent Extremist Organization (VEO), but only a few elect to become suicide bombers (Kruglanski, Chen, Dechesne, Fishman, & Orehek, 2009, p. 337). The difference between these two groups is primarily in the *degree* of motivation to sacrifice oneself for the group rather than the *kind* of motivation experienced.
- A survey in 2006 in 12 Middle Eastern countries as well as Pakistan and Indonesia found that the endorsement of individualistic objectives such as education, professional success, and raising a family were associated with significantly lower support for attacks on Americans (whether military personnel or civilians) than endorsement of transcendental goals such as defending one's nation or religion (Kruglanski, Chen, Dechesne, Fishman, & Orehek, 2009, p. 346).

Triggers

- Hard line international policy can actually promote conflict by cultivating support for extremist elements among one's adversaries by helping the adversary unite against a common enemy (Adelman & Chapman, 2011, p. 29).
- Various experiences can trigger one to undertake a quest for significance that could lead one to join a VEO or engage in political violence (Kruglanski, Chen, Dechesne, Fishman, & Orehek, 2009, p. 339). These include reminders of mortality through personal trauma, feelings of alienation, and disenfranchisement.

Strategic Interventions[6]

- The USG should not attempt to infringe its group norms onto someone else's including morals and ideas of democracy (Adelman & Chapman, 2011, p. 30).
- Psychological biases (which lead to greater in-group/out-group tensions) can be regulated (Bruneau, 2010, pp. 25-26) through intergroup contact. However, increased intergroup contact has only been shown to reduce biases in the dominant group. Therefore, while dominant groups may relax biases upon hearing about the subordinate group's difficulties, the subordinate group only (temporarily) relaxes biases by being actively listened to by the dominant group. Furthermore, research (Chiao, Cultural neuroscience: a once and future discipline, n.d., p. 295) indicates that temporarily heightening one's awareness of cultural values (like collectivism vs. individualism) can dynamically alter neural responses during visual perception.
- Dealing with terrorists' motivation appears of key importance (Kruglanski, Chen, Dechesne, Fishman, & Orehek, 2009, p. 351). Without undermining motivation, reducing terrorists' ability to launch a given terrorist tactic may often have a temporary effect, lasting until the terrorists discover a way to restore their constrained ability or find a new terrorist tactic free from prior limitations.

[6] See Allport et al. for discussion of countering intergroup violence.

SACRED VALUES

Sacred values are core values intrinsic to a person's identity, culture, and worldview. They are characterized as endogenous variables in this report because they are often adopted early in life through one's culture and environment, and attitudes and beliefs are not considered malleable (Hatemi P. , McDermott, Martin, & Stenner, 2010, p. 16). While sacred values and attitudes are not necessarily predetermined by one's genetics, they are a part of an individual's psychological architecture. Sacred values represent moral imperatives linked to a group's norms and narratives. Some suggest that these sacred values drive people to action, which flies in the face of theories that rely on a rational actor approach (Atran, 2011, p. 56; Chapman & Adelman, 2011, p. 11). Indeed, cross-cultural research has found that people will overlook the probability for success because their group-held sacred values are driving their behavior. Prominent thinkers like Charles Darwin, Thomas Hobbes, and Sun Tzu have long recognized the role of sacred values, moral imperatives, and moral virtue as a source of order and identity in an otherwise uncaring world (Atran, 2011, pp. 54-55).

Findings

Sacred values are considered an integral part of a person's identity and belief system. Extrapolating further, some suggest that **trying to change a person or group's values leads to hostility** (Hatemi P. , McDermott, Martin, & Stenner, 2010, p. 26). Why would sacred values prompt such extreme behavior? Evolutionary theory proposes an explanation based in kin selection or gene enhancement (Adelman & Chapman, 2011, pp. 11-12). To the extent that sacred values are group-based, that people hold their group (i.e., social identities) in high regard (as being very important), then taking action to defend the group by upholding or defending sacred values would be expected even if it seems irrational (Atran, 2011, p. 54). Additionally, sacred values "signal group identity and operate as moral imperatives that inspire nonrational exertions independent of outcome." People may ignore their personal desires in exchange for upholding sacred values.[7]

Certain individuals are more inclined to hold intolerant attitudes, and thus may be more prone to react violently if their values are threatened (Hatemi, McDermott, & Stenner, 2011, pp. 180,202). One frequent and flawed assumption of some nation-building plans is that once a population experiences the benefits of liberal democracy, it will change its value structures to match that type of governance (p. 178). However, because individual differences in tolerance are genetically informed (and not easily changed), trying to promote liberal democracy in populations where liberal values are not practiced may be perceived as a psychological attack and result in increased hostility (p. 179). Additionally, "cultural conflict is likely to emerge when the rules and values of one cultural group are substantially different from another, and members of the cultures come in contact with each other" (Berns & Atran, 2012, p. 635).

Flawed Assumptions

- No one individual is genetically or biologically predisposed to political violence (Hatemi, McDermott, & Stenner, 2011, p. 203). Rather, individuals who may be more disposed to engage in violence when threatened in general will become motivated to act because of particular provocations.

[7] See also C. Dawkins

Indicators

- Commitment, or lack of commitment, to sacred values can be key to the success or failure of insurgent or revolutionary movements that operate with far less firepower and material means than the armies or police arrayed against them (which tend to operate more on the basis of typical "rational" reward structures, such as calculated prospects of increased pay or promotion) (Atran, 2011, p. 54).

Triggers

There are many necessary, but not sufficient, factors that underlie political violence including demographic shifts, perceived grievances, and changing economic conditions that provide a platform for political violence. However, these cascading events only lead to political violence by certain triggers. For example,

- "Sacred values" can motivate "devoted actors" to act "irrationally" in ways all out of proportion to likely prospects of success (Atran, 2011, p. 54).
- Action becomes morally motivated by a shift in core cultural norms or "sacred values" (Atran, 2011, p. 55), which is often amplified through social media outlets.
- Democracy promotion strategies may help terrorist organizations recruit those most susceptible to aggression (Hatemi, McDermott, & Stenner, 2011, pp. 180,203). Any effort that is seen as attempting to alter a group's or individual's values, like democracy, is seen as a hostile and coercive act.[8] "American action designed to encourage the adoption of democratic values may serve as the very trigger to direct more rage against the perceived source of such provocation." [9]

Intervention Strategies

- While many conflicts originate over sacred values, the policy tools used to ameliorate the violence by U.S. policy makers are usually incentive based (Berns G. , 2010, p. 36). Incentives may work in a rational actor calculation, but people do not yield their sacred values to financial or material incentives. Standard cost-benefit approaches to defeating terrorism are therefore problematic (Atran, 2011, p. 58).
- Other counterproductive methods include supporting a corrupt regime and prioritizing U.S. security interests over U.S. sacred values of democracy, liberty, freedom, etc. (Atran, 2011, p. 58).
- Dr. Atran listed four intervention strategies that might succeed in reducing political violence in the case of AQAP in Yemen. These might not apply to all regions of the world, but are worth considering. He suggests that the best intervention strategy is, rather than supporting the government, providing support to the population to
    - allow exploration of new and competing ways to adhere both to representative democracy and to Islamic values;

[8] Hatemi, McDermott, and Stenner note that U.S. democracy promotion rests "on basic elements of Lockean liberal values, including free speech and democracy" (Hatemi, McDermott, & Stenner, 2011, p.180).
[9] It is important to note that "democracy" is an open-textured term. For example, Arab Springers have a different definition of democracy than the Tea Party and Occupy Wall Street members. There is a concerted effort in the Middle East and North Africa to tie democracy to Islam. This democracy is often different from what most Westerners mean. These different meanings of democracy must be kept in mind when thinking about fostering "democracy".

    - promote peer-to-peer (rather than government-to-government) communication and connectivity that fosters genuine and novel forms of social and political relationships and economic enterprise however inherently unpredictable and uncontrollable;
    - provide culturally appropriate models for heroic action that appeal to the idealism and passion of youth, to dreams of glory, and the search for dignity and respect; and
    - conduct policy-oriented research needs to explore ways to honor, rather than eradicate, tribal customs within a more open society.
- *Avoid focusing on democracy promotion strategies.* Democracy promotion, which represents one of the primary macro strategies that that U.S. government uses in its endeavors to reduce terrorism, actually inspires the very terrorist activity it is designed to prevent (Hatemi, McDermott, & Stenner, 2011, p. 180).
- *Do not equate anti-liberal values with terrorist values.* It is a flawed assumption to equate terrorists with anti-liberal values or to buy into the notion that all those with anti-liberal values are terrorists (Hatemi, McDermott, & Stenner, 2011, p. 182). This assumption immediately over generalizes the challenge confronting U.S. policymakers and unnecessarily makes instant enemies out of potential fiends who nonetheless share different values.
- *Promote change through developmental assistance, not programs than aim to change values.* Instead of trying to instill specific value in other populations, the USG should consider supporting those economic institutions and health and welfare programs that breed the emergence of stable governance and prosperity (Hatemi, McDermott, & Stenner, 2011, p. 207). Strategies that focus on supporting the development of science and technology will likely not be met with much resistance. These countries often "become illiberal democracies...This is the price of democracy. However, telling people how to think or which values they should hold dear, will be met with great potentially violent opposition" (Hatemi, McDermott, & Stenner, 2011, p. 208).

CULTURE

Culture is the learned patterns of behavior and thought that help a group adapt to its surroundings. Most people in the neurological and cognitive sciences prefer to refer to one's milieu as the "environment" instead of culture, which is a more amorphous term used primarily by social scientists. Hence, there is a great deal of overlap between the endogenous factors of culture and environment in this report.

Findings

Cultural experience influences behavior and brain function (Chiao, Cultural neuroscience of intergroup relations, 2010, p. 21; Chiao, Cultural neuroscience: a once and future discipline, n.d., p. 288)**.** Just as geography plays an important role in who and what we are (e.g., urban vs. rural), religion, ritual, and cultural traditions can define us as well. These ritualized behaviors, inherent to culture, alter the conceptual meaning of things like good/bad and right/wrong, which, in turn, can shape cultural identities and behavior vis-à-vis others who do not ascribe to the same belief systems. Culture and group membership matter and may be regulated by the amygdala (p. 22).

The amygdala influences responses to events in the environment, such as novel or ambiguous events that appear to indicate danger in the environment that is thought to occur from an

evolutionary perspective. The "fight, flight, or freeze" response that individuals have to a situation is regulated by the amygdala: for instance, people's tendency to approach or avoid a given situation may be affected by the extent to which the amygdala responds to a given event in the environment. Culture affects how people show enhanced amygdala response to affective scenes across cultures. People living in collectivistic cultures shown increased amygdala response to emotional scenes compared to people living in individualistic cultures, possibly due to the cultural importance of paying attention to the environment in geographic regions that have been historical or contemporarily affected within pathogen prevalence. Enhanced amygdala response to affective scenes may facilitate appropriate social behavior, within groups or situations that emphasize social harmony and contextual sensitivity compared to those that emphasize autonomy and identity continuous across situations and relations (Chiao, Cultural neuroscience: a once and future discipline, n.d., p. 296).

Cultural group membership provides an important means by which people infer the mental states of others from nonverbal cues (Chiao, Cultural neuroscience: a once and future discipline, n.d., p. 296). Nonverbal cues, such as facial or bodily expressions, provide an often subtle but important way of communicating the mental states of others, including their thoughts, beliefs and preferences. Culture exerts a significant influence on bilateral amygdala response to fear faces. Across cultural contexts, people show increased amygdala response to fear faces, social signals that cue danger in the environment.

Neural substrates of self-knowledge and self-awareness are modulated by cultural values of individualism and collectivism (Chiao, Cultural neuroscience: a once and future discipline, n.d., p. 297). Furthermore, cultural values (like collectivism vs. individualism), rather than cultural affiliation (i.e., East Asia, Westerners) per se, modulate neural response during self-evaluation.

There are **four cultural influences on emotion: in-group advantage, display rules, emotional sensitivity, and ideal affect** (Chiao, Cultural neuroscience of intergroup relations, 2010, p. 14). In-group bias allows a group member to recognize facial expressions (like fear) better by members of their own culture; infer nationality based on facial expressions (not just a neutral face); and infer in-group status based on phonetic and facial recognition (p. 15). Fear is an expression and emotion that warns others of threat and solicits help from others. The evaluation and response to threat cues is processed by the amygdala (p. 17). The amygdala may be part of larger neural network that facilitates group selection in empathy and altruistic behavior (p. 21).

There is **cultural variation in hierarchy preference that directly impacts empathic neural response and behavior** (Chiao, Cultural neuroscience of intergroup relations, 2010, p. 30). Hierarchical relationships may maintain social harmony in some cultures. Cultural variation in hierarchy preference predicts empathic neural response. There are six known cultural moderators of empathy (p. 34).

1. Social Dominance- good predictor of in-group empathy bias due to neural activity in the left temporo-parietal junction of the brain (p. 43)
2. Dispositional Empathy
3. Individualism-Collectivism
4. Ethnic Identity
5. Display Rules
6. Explicit Attitudes

Music has the potential to influence attitudes, social norms, and potentially behavior (Lemieux & Nill, 2011, pp. 143-144)**.** There has been a concerted and strategic use of music by VEOs to recruit and radicalize new members. Music is used to convey pieces of information (such as the identity of the enemy, the commemoration of heroes, the airing of grievances, increasing group polarization, and the means through which the grievances can be addressed). Two particular musical genres are the primary vehicles of radicalization music: hip hop and Nasheeds (chant-like forms of music without instrumentation). Adolescents may be particularly vulnerable to this form of recruitment as they are both more likely to access this type of music via social media and are more likely to be influenced by peer pressure. Music acts like other enforcing mechanisms of group norms and can reinforce a person's gradual radicalization. Additionally, music with aggressive or violent lyrics has the potential to increase the amount of aggressive thoughts and feelings, which can lead to subsequent violent behaviors. In a look at prisoner radicalization in the United States, researchers found that inmates were inspired towards extreme version of religion through sacred texts and rituals as well as hip hop music (Hamm, Prisoner radicalization: Assessing the threat in U.S. correctional institutions, 2008, p. 17).

Music establishes and reinforces social norms and identity (Lemieux & Nill, 2011, p. 145). The music one listens to and the message it conveys plays a pivotal role in establishing both social identity and group boundaries.

Music has the potential to intensify or diminish the trajectory of intergroup conflict (Lemieux & Nill, 2011, p. 146). Protest songs that evoke images of conflict appear to increase intergroup tensions. Folk songs emphasizing shared aspects of a common identity had the potential to blur the lines between protesters and security forces.

Playing first person, violent video games may prime some individuals for aggressive behavior (Mathiak & Weber, 2006, p. 949)**.** It is tough to reinforce brain patterns that condition a person to respond aggressively to stimuli. However, although researchers founds patterns of suppressed affective structures induced by virtual violent interactions, research has not proven whether the regular use of video games can promote aggressive behavior in real life (p. 954).

Terrorist groups are uniquely characterized by their own cultures (Matsumoto, Hwang, & Frank, 2010, p. 6). Cultural systems provide guidelines for normative behavior, the basis for the nature and function of attributions, communication systems, and intergroup relations. Terrorist organizations are characterized by sacred values and beliefs but then again so are many ideologically based organizations. Hatred of others is facilitated by a culture of disdain that is permeated throughout the group, and future generations are similarly acculturated. Emotionally laden narratives color the perception of all new information that confirms the narrative is taken at face value, and information that disconfirms that narrative is dismissed through accusations of bias, conspiracies, or even flat out logical fallacies.

Indicators

- By examining the themes and content of the music and the technical aspects of the music through leveraging the capabilities of social media (popularity, number of downloads, number of available channels, etc.), one may be able to **quantify the potential reach and impact of music on radicalization and recruitment efforts** (Lemieux & Nill, 2011).
- fMRI may reveal precursors of aggressive behavior through the activation of the anterior cingulate cortex (ACC), which is thought to be the interface between cognition and emotion

(Mathiak & Weber, 2006, p. 949). The ACC's function might reveal if and how a complex cognitive task like playing a first-person shooter game can have an impact on affective processing.

Triggers

- None identified

Strategic Interventions

- Relative to the prevention and minimization of the popular support for violent extremism, music can serve as an intervention because of its ability to communicate and manipulate affect (and thus behavior) (Fenstermacher, 2011, p. 21; Lemieux & Nill, 2011, pp. 148-9). Lemieux points to several successful efforts, suggesting several uses for music: to transmit countervailing (counter violent extremism) messages (e.g., the use of rock and roll to counter violent Salafi extremism which leverages its wide appeal), as a force for mediation and social change, for promotion of tolerance and reconciliation by providing alternate messages to vulnerable populations, and for providing the basis for furthering intergroup dialogue and reducing intergroup conflict. He stresses that any music-based counter messaging should consider emotional content, the role played by the performer in framing the context and message, the broadcast medium, and the use of messaging and themes to link emotions with musical and lyrical content.

NEURO-COGNITIVE DEFICITS

Some studies, especially early attempts at understanding terrorism (particularly suicide terrorism), have suggested that people who engage in violent extremism are afflicted by neurocognitive deficits or psychopathy that cause them to process and respond to stimuli with aggressive behavior. However, while there are probably some few extremists who do have neurocognitive deficits, this theory has been largely debunked in recent years. Both findings are presented below for consideration.

Findings

Neurocognitive imbalances (psychopathy) make some individuals prone towards violence (Nadelhoffer, et al., n.d., p. 17)**.** Research on psychopathy among the criminal population in the United States shows that psychopathy is a developmental disorder that often leads to persistent antisocial behavior. In fact, psychopaths are persistently violent. Individuals with psychopathy are notoriously domineering, exploitative of others, and deficient (or entirely lacking) in emotions such as guilt, remorse, and empathy. As such, they are stunningly hyper-aggressive, predatory, and recidivistic. Despite the fact that only 1 percent or less of the population in the United States is thought to be afflicted with psychopathy, some estimates suggest that individuals with psychopathy could nevertheless be responsible for as much as 30 percent to 40 percent of all violent crime. Structural and function brain abnormalities, particularly relating to the function of the amygdala, are frequently associated with psychopathy.

Terrorists are psychologically normal and there is no particular personality type that characterizes terrorists (Hatemi, McDermott, & Stenner, 2011, p. 204)**.** This is true even when looking at suicide terrorists who are, on average, similar in education level and economic status

compared to the general population. Terrorists are not mentally ill, emotionally disturbed, or depressed. People turn to political violence based on rational (to them) motives. In order to be an effective terrorist, one must be able to participate in an organized and deliberate effort to be successful. Psychopathologies such as anti-social disorders, schizophrenia, and other personality disorders would preclude such abilities.

Indicators

- There are tests to diagnose degree of psychopathy in individuals that is primarily used by the criminal justice system to determine a prisoner's risk of recidivism (Nadelhoffer, et al., n.d., pp. 17-18). The primary test is called the Psychopathy Checklist-Revised (PCL-R). This test measures an individual's propensity for socially deviant characteristics such as being superficial, grandiose, deceitful, lacking in remorse, lacking in empathy, not accepting responsibility, impulsive, and lacking goals.
- Recent research on the MAOA or "warrior gene" indicates that there might be a genetic, dispositional link to violence in some people (Nadelhoffer, et al., n.d., p. 20). The MAOA gene is involved in the regulation of serotonin and norepinephrine and has been shown in animal and humans studies to increase impulsive aggressive behavior. While the gene mutation is rare, there is a common polymorphism such that individuals can have a relatively high MAOA or low MAOA expression. This polymorphism does not predispose males towards violence but may increase the chance of an aggressive response to environmental stimuli such as an abusive childhood or exposure to violence.

Triggers

- None identified

Intervention Strategies

- None identified

EMOTION

> *One crucial aspect of human behavior that is often overlooked by researchers, operators, and policy makers is that of human emotion, the incorporation of emotion is central to an understanding of any individual or group behavior. On the individual level, emotions are evolutionarily evolved information processing systems that aid in survival. They are transient, fleeting reactions to events that have implications for one's welfare, and require immediate response. They prime behavior by initiating unique physiological signatures and mental structures. They aid in bonding memories and cognition. And most importantly, they are a major source of motivation for behavior*
>
> (Matsumoto, Hwang, & Frank, 2010, p. 2).

Findings

Trust, which is an emotion that mitigates violence, is regulated in part by a neurotransmitter and hormone called oxytocin (Zak, Presentation on Oxytocin, 2010, p. 46; Zak, The neurobiology of trust, 2008, p. 89). The oxytocin release system is complex and depends on a person's individual

threshold. Oxytocin facilitates cooperation and trust in mammals and is widely known as the hormone that prompts a nurturing behavior in nursing mothers. However, high stress situations and exposure to a violent environment inhibit oxytocin release. Additionally, acute stress raises testosterone levels, which also inhibits the functioning of the oxytocin system. Vasotocin, a similar hormone, seems to promote friendly interactions. Stress, uncertainty, and isolation work against the development of a trusting disposition.

Men exhibit an aggressive response to being distrusted in research studies (Zak, The neurobiology of trust, 2008, p. 92)**.** When male participants in one study were distrusted, their levels of dihydrotes-tosterone (DHT), a derivative of testosterone, went up. The more distrust men were shown in the game, the higher their DHT went. DHT is the hormone primarily responsible for changes experienced during puberty including body hair growth, increased muscularity, and vocal cord thickening. Elevated levels boost the desire for physical confrontation in trying social circumstances. Women did not display an aggressive response to being distrusted.

An ancillary effect of extended care for human children could be that humans have a powerful propensity for attachment and thus strongly attach to non-kin who become friends, neighbors, or spouses (Zak, The neurobiology of trust, 2008, p. 91). **Oxytocin helps people bond to others, which may fuel group-seeking behavior**. Natural selection favored people who could bond strongly with others over a long time.

Two genes are likely to play a pivotal role in the future of cultural neuroscience research: serotonin (5-HTTLPR) and dopamine (DRD4) (Chiao, Cultural neuroscience: a once and future discipline, n.d., p. 293). Possessing the serotonin gene 5-HTTLPR is associated with increased negative emotion including heightened anxiety, harm avoidance, fear conditioning, attentional bias to negative information, as well as an increased risk for depression in the presence of environmental risk factors, particularly in Western populations. In particular, exposure to chronic life stress, such as interpersonal conflict, loss, or threat, is considered a well-known environment risk factor for depression in these gene carriers, which is extremely prevalent in East Asian populations relative to other nations. The Dopamine receptor has been linked to novelty seeking and pathological gambling. This gene is prevalent in South American Indian populations, but extremely rare in East Asian populations.

Feelings of isolation increase a person's vulnerability to radicalization. In U.S. prisoner populations, individuals that experience isolation from friends and family are the most likely to seek out extreme forms of religious group belonging (Hamm, Prisoner radicalization and sacred terrorism, 2011, p. 18).

Groups can hate, but not all hatred leads to violence or hostility. **Hatred based primarily on anger and/or contempt will *not* be associated with violence or hostility, but hatred that involves disgust will. Disgust is an emotion that elicits feelings of repulsion and elimination**[10] (Matsumoto, Hwang, & Frank, 2010, p. 7). Anger prepares one to fight; disgust propels one to eliminate or repulse contaminated objects (p. 3). It is disgust, not anger, that is associated with a breakdown of a relationship, which could be seen as a component of hostile acts between groups. The elicitation of disgust across cultures is universal across cultures.[11] It is also a moral emotion

[10] See also Robert Sternberg and the duplex theory of hate for further discussion

[11] Interesting to note that disgust is also seen in rodents and other mammals and that moral values are processed in the same region as disgust.

and is often used to sanction moral beliefs and behaviors. There is often an escalation of disgust (as seen visually on leaders' faces or in their writings and speeches) leading up to acts of violence. Disgust transforms aggression, which sometimes can be constructive, into hostility, which is almost always not, and anger into hatred. When disgust is leveled against an entire group of people, they are perceived as inherently bad and require elimination (p. 4).

Group members feel anger toward out-groups when the in-group is in conflict with the out-group and the in-group view is the majority; this **anger will lead groups to confront, oppose, or attack the out-group** (Matsumoto, Hwang, & Frank, 2010, p. 4).

Violence and hostility are the direct result of the planned inculcation and careful, methodical nurturing of hatred in terrorist groups (Matsumoto, Hwang, & Frank, 2010, pp. 5-6). Hatred is often propagated via stories or narratives. This is done is three phases.

1. Create a sense of outrage based on anger
2. Reinterpret events and situations to create a sense of moral superiority based on contempt
3. Convince members that out-group needs to be eliminated based on sense of disgust

The outbreak of international wars is reliably preceded by drop in leaders' integrative complexity either bilaterally between two leaders or leadership groups (conflict spiral) or unilaterally (strategic surprise attack) (Suedfeld, n.d., pp. 2-3)**.** Integrative complexity (IC) refers to the ability of an individual or group to engage in complex cognition including recognizing the viewpoints of others, during complex or crisis situations. When crises become too stressful or complex, often, a simple solution such as resorting to violence may be sought. Other findings include (p. 3-5):

- IC remains stable or rises preceding peaceful solutions
- During period of escalating conflict, IC demonstrated by leaders of both sides declines within about four to six months preceding the outbreak of war
- Strategic surprise attacks are preceded by a major decrease in the IC of statements by the leaders of the eventual attackers only, beginning about 6 months prior to the attack
- During an enduring rivalry, drops of IC in one or both nations' leaders occurs within a few months of an outbreak of major war
- Recent studies have shown similar patterns preceding terrorist attacks and violent attacks against domestic political opponents

Secondary traumatization through narratives/images raises emotions resulting in violence. Charismatic leaders are adept at making use of highly emotional and vivid portrayals of real or perceived grievances (such as civilian casualties of military operations) to cause secondary traumatization in target populations, galvanizing them to action (Speckhard, 2011, p. 170). Emotions are particularly stoked if the leader is successful in defining those with grievances as fictive kin that need to be defended and avenged.

Indicators

- There is often an escalation of disgust (as seen visually on leaders' faces or in their writings and speeches) leading up to acts of violence (Matsumoto, Hwang, & Frank, 2010, p. 3).

- A drop in integrative complexity on the part of a leader as exhibited by his speeches or actions predicts government-directed domestic political violence (Suedfeld, n.d., p. 4).

Likewise, a drop in integrative complexity on the part of a VEO leader precedes terrorist attacks.

Triggers

- None identified

Intervention Strategies

- Establishing trust with an adversary reduces the likelihood of violence. Therefore, framing policy issues as zero-sum games create a negative feedback loop that results in increased aggression. Pro-social policy issues may mitigate the inhibition of oxytocin and increase the level of trust between groups/nations. (Zak, Presentation on Oxytocin, 2010, p. 47)
- There is no evidence currently that surreptitiously exposing leaders to oxytocin will cause two opposing leaders to trust one another (Zak, The neurobiology of trust, 2008, p. 92)

EXOGENOUS FACTORS

Exogenous factors are external influences on a person that are not inherent to one's personality, culture, genetics, etc. These factors are often triggers that move a predisposed person to take action. Exogenous influences include exposure to narratives, radical social networks, perceived grievances, and traumatic life experiences. Exogenous variables are represented on the right side of Figure 1 under the Action Pyramid.

NARRATIVES

A narrative "is a system of stories that share themes, forms, and archetypes. Every story in a narrative need not have exactly the same characteristics; however, they relate to another in a way that creates a unified whole that is greater than the sum of its parts" (Corman, 2011, p. 40). These individual stories "influence our ability to recall events, motivate people to act, modulate our emotional reactions to events, cue certain heuristics and biases, structure our problem solving capabilities" (Casebeer W. D., 2005, p. 5). Narratives are important "because they present an alternative form of rationality" that is "based on whether an audience can see positive outcomes from a story and can align it with their values" (Corman, 2011, p. 42). Narratives help an individual frame the world in which they are living.

Findings

"**Narrative rationality can trump logical reasoning** because it is an alternate way of thinking about the world that has close connections with desires and emotions, and is deeply involved with how we make sense of events in everyday life" (Corman, 2011, p. 42).

The **success of a "narrative depends upon which actors construct it**" (Casebeer W. D., 2005, p. 2). "Militant jihadi groups are currently highly successful in promulgating their ideological messages and through the skillful use of emotionally manipulative messaging, recruiting, motivating, and equipping, men and women all around the world to become highly lethal terrorists" (Speckhard, 2011, p. 170).

Many narratives are dependent upon successful creation of myths. "Myth creations involved the weaving together of the narrative elements of a story with facts about past and present situations to create an emotionally compelling backgrounds that very often directly influences the susceptibility of a population to manipulation by 'myth mongers'" (Casebeer W. D., 2005, p. 8). One popular narrative is the common enemy, and this "becomes the frame through which locals interpret their grievances—be they local, national, or ideological in nature" (Everington, 2011, p. 82).

Triggers

- Currently, there is not a very good understanding of which messages work, but "if we can figure out which communications are effective and which are not, and *why,* we'll be much closer to understanding the triggers that cause people to join extremist movements" (Romero, 2010, p. 8).

Intervention Strategies

"A grand counter-terrorism strategy would benefit from a comprehensive consideration of the stories terrorists tell; understanding the narratives which influence the genesis, growth, maturation and transformation of terrorist organizations will enable us to better fashion a strategy for undermining the efficacy of those narrative so as to deter, disrupt, and defeat terrorist groups" (Casebeer W. D., 2005, p. 3). Governments can counter narratives that shape the process of narrative selection and retention through

- destabilizing existing narratives that promote radicalization (Dillard, Uses of narrative in promoting and countering violent extremism, 2011, p. 11);
- introducing new narratives for counter radicalization (Dillard, Uses of narrative in promoting and countering violent extremism, 2011, p. 12); and
- destroying a group's foundational myth and creating competing myths (Casebeer W. D., 2005).

DEHUMANIZATION

Dehumanization is a mental process that rationalizes the use "violent or degrading acts…not typically reserved for people" against an individual or group. It reduces an individual's worth to level of animals or machines (Harris, 2010a, p. 34), (Matsumoto D. H., 2010, p. 4). Dehumanized subjects are perceived as not worthy of human emotions such as empathy, reinforcing their degraded status (Harris, 2010b, p. 48). This process of dehumanization of the other is an important step in an individual's radicalization: it allows a person to rationalize committing violence against others.[12]

Findings

Moral disengagement is defined as an "internal thought process by which an individual is able to disengage his or her own inner moral control to justify inhuman conduct." This process allows "an

[12] See also Albert Bandura's mechanisms of moral disengagement for additional discussion of dissociative mechanisms, of which dehumanization is one

individual or group to disengage from their self regulatory standards and exonerate their violent behavior" (Rate & Neff, 2012, p. 1). This is important in Islamic extremism where many messages produced run "counter to the moral teachings of Islam" (Rate & Neff, 2012, p. 2).

Music has been indicated as a medium that can "foster harsh negative and de-legitimizing images" and "identify and portray enemies and out-groups in negative terms" (Lemieux & Nill, 2011, p. 149). It has been theorized that these portrayals "may be received less critically by their target audience when set to music because it engages them on a more emotional level." These negative portrayals can "be used to advocate or support taking actions against a particular enemy." Additional studies found that

- dehumanized subjects are seen as "not nice and inept" and "elicit disgust"[13] (Harris, 2010a, p. 10);
- "people are more willing to sacrifice and less willing to save dehumanized targets" (p. 22); and
- "people punish dehumanized targets more and restore them less" (p. 22).

Triggers

- Preliminary data suggests that viewing an individual as an obstacle to a highly valued goal can trigger dehumanization (Harris, personal communication, 4 June 2012).

Intervention Strategies

Several instances in which music was used as a successful intervention strategy have been identified. Music can be used (Lemieux & Nill, 2011, p. 21)

- to transmit countervailing (counter violent extremism) messages;
- as a force for mediation and social change;
- for promotion of tolerance and reconciliation; and
- to provide the basis for furthering intergroup dialogue and reducing intergroup conflict.

However, "any music-based counter messaging should consider emotional content, the role played by the performer in framing the context and message, broadcast medium, and the use of messaging and themes to link emotions with musical and lyrical content" (Lemieux & Nill, 2011, p. 21).

SOCIAL NETWORK

A social network is an individual's "network of friends, colleagues, and other personal contacts" (Social Network, 2011). These networks have been shown to be a critical component of a person's radicalization process: people who spend time together influence each other. Various studies from across the fields of psychology, neuroscience, and sociology have highlighted the importance that a person's social network plays in influencing a person to embrace political violence. With regard to AQAP, "recent examinations of fighters have shown that many are from the same tribe," suggesting that "friends and family are the main influence on an individual" (Atran, 2011, p. 19).

Findings

[13] The emotion disgust is discussed further in the emotion section.

One hypothesis states that "the **most effective way to radicalize and de-radicalize people toward or away from violent extremism is primarily through peer-to-peer and generation-to-generation activation of local social networks**" (Atran, 2011, p. 18). Activation of local social networks includues the ways in which people share common values, beliefs, culture, and tradition. Although the research does not point to how to activate these local networks, peer-to-peer networks are critical. In the American prison system, radicalization occurs "by other inmates, not by outside influences" (Hamm, 2011, p. 13). This "radicalization occurs through one-on-one proselytizing by charismatic leaders" (Hamm, 2011, p. 13). Through interviews and evaluation of the prison system, it has been shown that people surrounding the indiviudal have the most influence on their thoughts and actions. In many instances of gang recruitment, inmates are radicalized by other radical inmates, not outside souces (Hamm, 2011). The "bunch of guys" hypothesis states "a group of (mostly) men join, create a cell, adhere to the norms of their group" and eventually they "create their own 'echo chamber,' where only acceptable voices are heard and opinions reinforced" (Gupta, 2011, p. 54).

Indicators

- Prison research suggests that the most isolated individuals—those with the fewest contacts with family and friends—are the most vulnerable to religious conversion and radicalization (Hamm, 2008, p. 14).
- "The actions of a person's family and friends a strong predictor of determining if a person will join a group" (Atran, 2011, p. 19). That is, if a person's friends and/or family have joined a group, the likelihood that the individual in question will increases.
- Exposure to "sacred texts, rituals and practices" and "literature, music, and hip hop" (Hamm, 2008, p. 16) was cited as an inspiration for prisoner conversion and radicalization.

Triggers

- Simply spending time with radicalized people—whether voluntarily (e.g., in a chat room) or involuntarily (e.g. in a prison cell)—increases the likelihood of an individual's radicalization (Hamm, 2011). The closer people live to one another or the more time they spend together affects the individual's behavior.

Intervention Strategies

- Supporting truly moderate elements within Islamic society may quell radicalization (Hamid, 2011, p. 80).
- Countering extremist violence should focus on peer-to-peer efforts. "It will take mobilizing the purpose seeking, risk-taking, and adventurous spirit of youth for heroic action" (Atran, 2011, p. 19).

With regard to the American prison system, Dr. Hamm identified the following intervention strategies (Hamm, 2008, pp. 18-19).

- Prisons could increase the diversity of corrections personnel including guards, counselors, and chaplains to cut down on feelings of "outsider-ness" of Muslim prisoners.
- Through greater prison staff training on recruitment and everyday activities of gangs, radical group dominance would be curbed.

DEMOGRAPHICS & PERCEIVED GRIEVANCES

Over the last several decades, many researchers have blamed demographic factors (like poverty) and perceived grievances (like racial discrimination) for pushing some individuals down the radicalization pathway. However, "people in similar environments often have radically different political views" and only a relatively small number of people choose violence (Hibbing, 2010, p. 6). Therefore, it is not *solely* demographics that radicalize an individual: "the fact remains some people in a given environment engage in violence but most do not" so "something else combines with their strong beliefs to lead them to commit violence" (Hibbing, 2010, p. 61). Research suggests that if an individual or group feels threatened, they will engage in violence, regardless if the threat is real or not. These perceived grievances matter in part due to ideology. "By ideology, one usually means a belief system centered upon some social or collective *ideal* (e.g., based on the values of justice, fairness, or inalienable rights). Ideology's motivating power resides in its identifying a *discrepancy* from an ideal state and offering a means of removing the discrepancy through action. A *terrorism justifying ideology* identifies a *culprit* (the enemy, e.g., the West, Israel) presumed responsible for the *discrepancy* and portrays violence against that culprit (e.g., jihad) as an effective *means* for moving toward the ideal state" (Kruglanski, Chen, Dechesne, Fishman, & Orehek, 2009, p. 333).

Findings

Those who commit violence "feel threatened and are fighting back against the course of that perceived challenge" (Hatemi, McDermott, & Stenner, 2011, p. 204). Violence occurs when "people feel deprived of what in their eyes constitutes their 'fair share'" (Kruglanski, Chen, Dechesne, Fishman, & Orehek, 2009, p. 345). It is important to note that this is relative deprivation rather than absolute deprivation; it is the feelings that an individual or group "had less than they deserved" (Kruglanski, Chen, Dechesne, Fishman, & Orehek, 2009, p. 345).

Some individuals are motivated to radicalism in societies with changing demographics, namely immigration and migration . These individuals are radicalized through a "lethal cocktail of:

1. a sense of alienation and marginalization for those temporarily or for generations transplanted out of their original cultures;
2. a loss of positive self concept/identify, (both of which are met by group dynamics, loyalty, and a sense of belonging to the group);
3. a desire for adventure;
4. and life meaningfulness;
5. a resonance to secondary traumatization occurring in the first group (i.e. identifying with traumas and injustices done for instance to Muslims in Chechnya and Palestinian territories) and indirect traumatization from viewing images of these populations on television and internet; and
6. lastly a desire for personal redemption from corruption." (Speckhard 2005, p17)

Indicators

- None identified

Triggers

- Triggers include a sense of humiliation that "may betoken an acceptance of one's inferiority and hence a profound sense of significance loss" (Kruglanski, Chen, Dechesne, Fishman, & Orehek, 2009, p. 346).

Intervention Strategies

- None identified

LIFE EXPERIENCES

Many experiences shape an individual. Some of the experiences are "very tangible factors--a history of violence, competition over scare resources—that can drive people toward political violence" (Dubin, 2002, p. 24). Other experiences include military experience, level of education, sexual deprivation, and the amount of conflict an individual is familiar with. Although these experiences do not fit into one specific theory, they influence an individual and are significant in their decision-making and radicalization process.

Findings

In leaders, **military experience increases "the probability of a leader initiating conflict**" (McDermott, Exploring the biological bases of leadership, 2010, p. 6).

Higher levels of education increase a decision maker's liklihood of initiating disputes, but reduces the liklihood that he or she will likely escate to war (McDermott, Exploring the biological bases of leadership, 2010, p. 7). A military education "makes leaders more likely to face conflict initiation." That is, leaders are more likely to confront conflict initiated by others against them.

The conclusion that **sexual deprivation plays a role in the development of suicide bombers** in the case of Islamic extremism is based upon the following observations (Hamid, 2011, p. 78):

- "Suicide bombing is prevalent among young males when the testosterone level is highest"
- "Suicide bombing is far less prevalent among young Shia Muslims compared to Sunnis." This may be because Shia theology permits temporary marriage "to meet emotional or human needs"

Individual vulnerabilities are important factors in an individual's radicalization. The amount of conflict surrounding a person impacts their radicalization. **Individuals living inside a conflict zone are radicalized for different reasons than those outside conflict zones**. Radicalization inside conflict zones stems from factors such as personal traumatization and desire for revenge while outside conflict zones it stems from dire poverty, social marginalization, and a desire to be heroic (Speckhard, 2007).[14]

Triggers

- Individuals outside conflict zones are exposed to the traumatic experiences of those *inside* conflict zones through pictures and films, which incites them to support and join terrorist groups (Speckhard, 2007).

[14] See also Speckhard 2005; Speckhard 2006a; Speckhard 2006b; Speckhard 2007; Speckhard 2010.

Intervention Strategies

- It is suggested that addressing factors that underlie sexual deprivation (e.g., making marriage more feasible through economic assistance) can alleviate it. This would "interrupt the radicalization process, and reduce the number of suicide attacks by *jihadists"* (Hamid, 2011, p. 78).

SOCIAL MEDIA

Social media is "a group of Internet based applications that build on the ideological and technological foundations of Web 2.0[15] and creation of user generated content" (Kaplan, 2010, p. 61). Social media allows for the instantenous transfer of information and connects people across the globe. It creates virtual communites of like minded individuals who offer support and new ideas. Radical groups are using social media to propagate ideas to audiences that would otherwise not have access to them. The spread of ideas "in the age of the Internet is a double-edged sword; it can enhance our collective welfare, as well as produce forces that can destablize the world" (Gupta, 2011, p. 56). With instantenous communication, there is the increased "potential of relatively isolated events to destabilize the world in unforeseen ways with far reaching consequences," (Gupta, 2011, p. 55) which did not exist before.

Findings

Social media and other forms of modern communication "do not by themselves radicalize anyone. Rather they are the channels that enable preconcieved attitudes to solidify" (Everington, 2011, p. 85). Research suggests that virtual communites allow "individuals [to] develop social capital, share ideological intrepreations, provide emotional support, raise money, stroke the fire of hatred toward outgroups, and plan future attacks" (Gupta, 2011, p. 55).

Social media may also be changing the structure of radical groups (Gupta, 2011, p. 55). Rather than a heirarchy of power, groups are "expansively networked, open-sourced, decentralized conglomorations of small quasi-independent individuals hewn together by a common source of inspriation."

Triggers

- When dramatic events are reported through the "new media of cyberspace" they have the potential to "transform ideas into realities, in ways that can inflame the passions of a small group of a target audience" (Gupta, 2011, p. 56).
- "The moral impetus for revolutionary change develops and gains potency in a population through the information media that disperses and channels the message and that amplifies, dampens or distorts its meaning and significance" (Atran, 2011, p. 55).

Intervention Strategy

- Current intervention strategies, including counter-radicalization commercials and SMS messages, "are ineffecive by themselves at triggering a change in attitude or behavor. The

[15] Web 2.0 describes web applications that foster information sharing and is user centered.

media should be used to shape the general environement in which the seeds of counter-radicalization can be sown" (Everington, 2011, p. 85).

- Understanding how ideas are spread and what makes them compelling is "essential for developing strategies for the prevention, detection of the emergence, and tracking of violent extremism" (Gupta, 2011, p. 57).

STRATEGIC INTERVENTIONS

Adapted from Dipak K. Gupta

Strategic interventions are ways in which outside actors, like the government or interest groups, can influence the de-radicalization process. These are policies and programs that halt and reverse the radicalization that an individual has gone through. There are two main motivations for joining terrorist organizations: self-interest and group-interest. This dual motivation creates different kinds of radicals. Those whose primary motivation is the perceived collective good are the "true believers" or the ideologues. Those who are motivated by self-interest are defined as mercenaries, that are the criminal elements found in many ideological groups. Finally, there are those who join out of fear. They have no vested interest nor do they have any ideological commitment to the cause. Based off of these broad categories, different strategic interventions are needed for the different categories. For example, for ideologues we need *inter alia* de-radicalization programs. The mercenaries are best dealt with within the traditional law and order system. The captive participants, in contrast, require the provision of personal security and the provision of public goods that governments often fail to deliver. There are not "catch all" intervention strategies. Variables of each situation must be taken into account when developing intervention strategies.

CONCLUSION

Multidimensional problems, like radicalization and political violence, call for multidimensional responses to mitigate the root causes of violent extremism (Shanahan,2011). Employing social science methods and theories alone results in an incomplete picture of radicalization that minimizes the importance of an individual's or group's neurobiology on behavior. Additionally, insights revealed by neurobiology research serve to enhance assumptions and practices in the operational community, potentially leading to more effective counter-radicalization efforts.

Recent advances in neurobiology over the last decade have yielded insights relevant to aggression and violence that are trickling into the national security arena. Planners, analysts, and decision makers will gain additional insights into radicalization and political violence from insights from the biology of behavior. This document is one attempt at introducing novel concepts of the interaction of the brain and the environment to operational users. As the field advances and more research is conducted in the national security sphere, neurobiology may become a critical component of planning and analysis within the U.S. Department of Defense. In the meantime, the SMA effort will continue to foster a community of interest that bridges the operational and neurobiology community.

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APPENDIX B: ACRONYMS

ACC	Anterior Cingulate Cortex
Ach	Acetylcholine
AQAP	Al Qaeda in the Arabia Peninsula
CNS	Central Nervous System
CSF	Cerebrospinal Fluid
CT	Compute Tomography
DHT	Dihydrotes-tosterone
ECG	Electroencephalogram
ENB	Evolutionary neurobiology
fMRI	Functional Magnetic Resonance Imaging
GABA	gamma (γ)-aminobutyric acid
GWAS	Genome Wide Association Studies
IC	Integrated Complexity
LHS	Life History Strategy
MAOA	Monoamine oxidase type A
MEG	Magnetoencephalography
mV	millivolts
MZ	Monozygotic
PCL-R	Psychopathy Check List-Revisited
PET	*Positron Emission Tomography*
PNS	Peripheral Nervous System
PTSD	Post Tramatic Stress Disorder
SMA	Strategic Multilayer Assessment
TSST	Trier Social Stress Test
VEO	Violent Extremist Organization

Sending a Signal: Common Neurotransmitters

The most common transmitter is *glutamate*, an amino acid that is excitatory at a vast majority of the synapses in a human brain. The next most prevalent transmitter is *gamma (γ)-aminobutyric acid (GABA)*, which is inhibitory at a majority of the synapses that do not use glutamate. Other common neurotransmitters include *acetylcholine, catecholamines* (*epinephrine, norepinephrine,* and *dopamine), serotonin, vasopressin,* and *oxytocin.*

Acetylcholine, sometimes abbreviated *Ach*, is a transmitter in both the *peripheral (PNS)* and *central nervous systems (CNS).* The Peripheral Nervous System connects the Central Nervous System, which includes the brain and spinal cord, to the limbs and organs of the body. In particular, acetylcholine has a primary role in the *autonomic nervous system*, or the part of the peripheral nervous system that controls functions that are generally below the level of consciousness, like heart rate, digestion, respiration, and perspiration. Acetylcholine is also the neurotransmitter used at the neuromuscular junction, or connection between motor nerves and the muscle. Acetylcholine activates muscles by opening sodium channels that ultimately lead to muscle cell contraction. In the brain, Ach, in addition to other neurotransmitters, plays a role in *synaptic plasticity,* or the ability of the connection (synapse) between neurons to change in strength—a neurochemical foundation of learning and memory.

Catecholamines can act as neurotransmitters in the brain, or as hormones that are generally associated with the body's "fight, flight, or freeze" response. The three catecholamines (norepinephrine, epinephrine, and dopamine) can be synthesized in the brain and also in the adrenal glands, but are also produced in some parts of the brain. The release of catecholamines causes the body to prepare for physical activity by increasing the heart rate, blood pressure, and blood glucose level. *Epinephrine,* also known as adrenaline, and *norepinephrine are* released by the adrenal glands (which sit on top of the kidneys) when the brain signals the need for an instantaneous reaction. The release of these two hormones triggers the suppression of non-critical body functions and the priming of the body for a "fight, flight, or freeze" type response. In the brain, norepinephrine affects alertness and arousal as well as exerting influence on the reward system within the brain, which endeavors to regulate and control behavior by inducing pleasurable effects. Epinephrine is synthesized from norepinephrine, which, in turn, is synthesized from *dopamine.* In the brain, dopamine serves many important roles including effects on sleep, mood, attention, working memory, and learning. Dopamine also plays an important role in the reward system in the brain, providing a feeling of pleasure when released; dopamine is the neurotransmitter most often associated with cocaine highs.

Serotonin is a monoamine neurotransmitter that is largely localized to the gastrointestinal tract (the stomach and intestines) where it plays a primary role in the *enteric nervous system,* or the nervous system regulating digestion. In the brain, serotonin has many functions, including the regulation of mood, sleep, appetite, and muscle contraction. Low serotonin levels in certain areas of the brain are linked to clinical depression, for example.

Oxytocin ("the trust hormone") is a brain protein and neurotransmitter that also functions as a hormone outside of the brain. Oxytocin is most closely associated with its role in inducing labor and facilitating breastfeeding, but, within the brain, of both men and women, it plays important roles in

a variety of behaviors including pair bonding and anxiety. Oxytocin is primarily produced within the hypothalamus, which is the brain's master controller of the body's autonomic and endocrine activity, among other things. Importantly, oxytocin reduces the release of stress hormones and reduces heart rate and blood pressure.

Vasopressin is a brain protein, closely associated with oxytocin that is also made in the hypothalamus. In men, vasopressin is typically associated with vigilance and mate guarding—though both behaviors are evident in women, to a lesser degree. More generally, vasopressin has been implicated, with some controversy, in memory formation, as well as aggression and the regulation of blood pressure and temperature.

Observing Chemistry Experiments in the Brain

The above discussion likely begs the question of how scientists are able to see into a functioning brain and readily observe action potentials or neurotransmitters doing their business. Recent improvements in imaging technology as well as our understanding of micro-circuitry have provided neuroscientists with unparalleled access to neurons and the brain. Nonetheless, despite expensive technology and significant innovation, questions remain about how the brain works.

Many people who have undergone a cardiovascular stress test are familiar with an ECG or electrocardiogram—a test that is very similar to an *EEG* or *electroencephalography*, which is a method by which the electrical activity of large groups (nuclei) of neurons can be studied simultaneously. This data is commonly collected using a cap like device with tens or hundreds of electrical diodes that rest on a subject's scalp and amplify the minute electrical oscillations within the brain. An EEG fails to elucidate structural anomalies or elements of the brain and its ability to characterize brain waves is limited to the outer layers of the cortex, but *BOLD fMRI*, or blood oxygen level determination functional magnetic resonance imaging, is able to peer into the brain and visualize the underlying brain structures, while exploring differential brain activation. Functional MRI does this by detecting localized changes in brain activity by recognizing that a recently activated brain region undergoes localized, rapid changes in brain oxygen concentration (i.e. oxygenated blood flows to areas of greatest need).

Other means of peeling back a subject's skull and examining the brain include *Positron Emission Tomography (PET) scans, magnetoencephalography (MEG),* and *Computed Tomography (CT) scans. PET* uses trace amounts of short-lived radioactive isotopes to localize regions where specific molecules of interest are involved in brain function. Positrons, or positive electrons, are emitted during the radioactive decay of the marker molecules used in PET scans, which a computer than triangulates to isolate the emission and the concurrent decay to the specific part of the brain where the radioactive tracer concentrated. Unfortunately, PET scans must be near a cyclotron capable of producing the radionuclide tracer due to the tracer's short half-life (or quick decay). Additionally, few radiotracers are capable of crossing the *blood brain barrier,* or the cellular barrier preventing many molecules from entering the brain via the blood. By limiting the kinds of molecules that can cross the blood brain barrier, the brain is at a lower risk of infection by pathogens; however, the barrier often prevents therapeutic agents from reaching the brain.

MEG monitors transient magnetic fields that result from neuronal activity by making use of the fact that time varying currents cause tiny, localized magnetic fluctuations. Finally, *CT scans* build up a picture of the brain based on the differential absorption of x-rays. Sometimes referred to as a 'CAT' scan, the test involves rotating an x-ray emitting device around a subject's head which is then

detected by x-ray detectors on the opposite side of the skull—because x-rays are not particularly good at resolving soft tissues, CT scans reveal the general features of the brain, but do not characterize its features particularly well.

Originally, brain research depended upon *lesion studies,* which are primarily conducted on individuals suffering from isolated and identifiable brain injuries due to accident, disease, or a surgical lesion. Such studies rely upon the correlation between some neurological deficit or behavioral anomaly and the site of the injury. Given that the utility of a lesion study depends upon the availability of many subjects with the same injury in order to make causal findings, lesion studies have largely fallen into desuetude. Nonetheless, the injuries of Mr. Phineas Gage[16] in 1848 laid the groundwork for the neuroscientific and neurobiological research to follow and the anecdotal findings of clinicians caring for injured or ill patients can provide useful hypotheses for further research by neuroscientists.

Interesting Findings from the Field:

The neuroscience literature contains many fascinating findings that are at the cutting edge of modern neuroscience. Nonetheless, in the next few pages, we have endeavored to outline several interesting findings in neuroscience and neurobiology over the past decade:

Gender Differences:

Vasopressin and oxytocin are closely related neuropeptides and yet they seem to have differential effects on men and women, suggesting that sex hormones like estrogen and testosterone play important roles in the brain that could explain many gender differences. Consistent with this conclusion is the finding that men have a generally more pronounced stress response than women, according to repeated administrations of the TSST (Trier Social Stress Test), a standardized test that requires study subjects to speak extemporaneously before an audience in a mock job interview (Harmon-Jones & Winkielman, 2007) (pp. 61).

These sex and sex hormone related differences have also been demonstrated in other contexts, including an iterative war game in which two anonymous partners can choose to attack their opponent or not. According to this research, scientists have found that sex, as well as a lower, more traditionally male ratio between the length of the pointer and ring fingers of research subjects "predicted unprovoked attack independently" (McIntyre, Barrett, McDermott, Johnson, Cowden, & Rosen, 2007).

Oxytocin and Social Support:

[16] While working on the California railroad Mr. Gage survived the impalement of a railroad rod through his head, the injury severely damaged both his left and right frontal lobes resulting in an observable change in demeanor**Invalid source specified.**. An 1868 report by Gage's physician in fact noted that Gage's "mind was radically changed, so decidedly that his friends and acquaintances said he was 'no longer Gage'". A lesion study conducted by Damasio et al. in 1994 provided scientific evidence supporting the historical account that Mr. Gage's behaviors and actions were radically altered by the accident. Damasio et al. compared computer-generated images of Gage's skull to those of other patients who had suffered damage in the same area of the brain and in fact had exhibited similar symptoms, such as a defect in rational decision making and difficulty processing emotion. Through the observation of changes in behavior and the comparison of identical brain damage in other patients researchers were able to identify the critical role that the frontal lobe plays in decision-making, emotion regulation, and behavior.

People with extensive social support networks appear to be the most resilient in the face of tragedy or stress—a finding substantiated by neuroscientific inquiry. According to researchers, oxytocin has been found to reduce stress responses in animal studies. In combination with social support, oxytocin appears to reduce *cortisol,* a stress hormone released by the adrenal glands, as well as increasing calmness and reducing anxiety. Thus, "oxytocin seems to enhance the buffering effect of social support on stress responsiveness, at least in men" (Harmon-Jones & Winkielman, 2007, p. 66). It should be noted that cortisol is a member of the *glucocorticoid* family of steroidal hormones. As such, cortisol is the primary hormone that produces the *flight, fight, or freeze* response (Haller & Kruk, 2003). Glucocorticoids, like cortisol, play an obvious role in the face of acute stressors; they also play a role in responses to chronic stressors and may alter neuronal pathways. The ability of oxytocin to counteract the simulative effects of cortisol suggests that social support and oxytocin may diminish the deleterious effects of chronic stress, like persistent anxiety.

Violence and Aggression:

According to some fMRI studies, there is evidence to suggest that individuals with a history of violent behavior "exhibit functional neurobiological differences in the prefrontal regions subserving working memory, in comparison with healthy controls of normal intelligence" (Loeber & Pardini, 2008). The strong association between specific personality types and a proclivity to violence suggests that there is a close genetic and biological linkage between phenotypic traits and underlying genotypic traits. Indeed, some researchers have identified certain biological pathways for a proclivity to violent behavior; accordingly, individuals with a biological risk for aggression might be particularly vulnerable to the effect of adversity because genes for the serotonin transporter "monoamine oxidase type A (MAOA) interact with childhood maltreatment and adversity to predispose to violence" (Siever, 2008).

Trust:

Correlation studies have found that trust is highest among the better educated, those in professional occupations and higher income groups, lowest among divorcees, the unemployed, ethnic minorities with a history of discrimination, and those in poorer health. At a more macro level, countries with more trusting people are generally more economically developed, have lower levels of state corruption, income equality, criminality and juvenile delinquency (Sturgis, et al., 2010). Nonetheless, some studies have currently suggested that there is evidence for a neurochemical cause for trusting—that some people may be more trusting than others because of basic matters of brain makeup and wiring rather than learned experience. This evidence has arisen out of iterated trust games, lending "further *prima facie* evidence to the notion of a biological underpinning to the trusting propensity" (Sturgis, et al., 2010).

The Role of Genes in Neuroscience

Delving deeper into the biological underpinnings of neuronal function, researchers are studying the foundational role played by *genes,* which are the basic units of heritary traits. Genes are composed of DNA and provide the codes, or template for specific proteins in the operation and longevity of neurons and all of the cells of the human body. At its core, *neurogenetics* studies the role that genes play in nervous system function and behavior; put another way, the fundamental question posed by neurogenetics is 'where do animal (and human) behaviors come from and are they controlled by genes?" and are behaviors then, heritable (Vosshall, 2007)? Since nearly all biological activities are

dependent upon the source code inherent to the *DNA*, or Deoxyribonucleic Acid, neurogenetics is a further narrowing of the lens through which we can view social and cognitive activities.

One of the primary functions served by genes is their role in *protein synthesis*, or the process by which a cell creates new proteins for use as enzymes, in cell structures, and as message-bearing molecules, among many other functions. In the neurosciences, the ways in which underlying genetic variations impact neural function and behavioral tendencies are nuanced and often very hard to isolate. Nonetheless, this section seeks to provide a summary of the basic terminology and techniques at use in this sub-field of the neurosciences.

It is important to recognize that the shorthand phrase of a gene 'for' a condition is profoundly misleading and incorrect—any given characteristic is generally a result of many genes, not just one. Genes for something as simple as brown eyes are situated across several different chromosomes; therefore, genes for specific neurological characteristics cannot often be isolated to one or even a few 'genes.'

Nature or Nurture: The Dangers of Neurogenetic Determinism

Neurogenetics considers neural characteristics as *phenotypes,* physical manifestations of genetic coding, and is largely based on the observation that the nervous systems of individuals, even of those belonging to the same species, may not be identical. The phenotype can vary widely. Cells differentially express genes and proteins based on the kind of cell type they are. Neurogenetics merges concepts and techniques from neurobiology and genetics to study the genetic basis of behavior and neural function. By generating and studying genetically modified animals, so called animal models like *Drosphila Melanogaster* (common fruit fly) and *C. Elegans (*nematode) are very common in the field, that exhibit abnormal behavior, mistakes in neural wiring, or anomalies in the structure or function of neurons, neurogeneticists can identify and understand the function of the genes in producing a normal brain and its associated behaviors.

The study of neurogenetics offers the prospect of identifying and ascribing causal power to genes affecting the brain and behavior. In the future, different therapeutic agents may be targeted to specific genetic conditions and underlying tendencies. Much as the Human Genome Project promises to alter the way that medicine is practiced in the rest of the body by determining the relative risks for disease and drug-response profiles, neural genetics, and a comprehension thereof, can potentially change the way congenital neurological conditions and psychiatric disorders may be treated.

Despite the apparent one-to-one connection between one's underlying genetic code inherited from our parents, it is unfair to assume that an 'aggressive brain,' one with genetic markers consistent with particular neurotransmitter and structural pathways, will necessarily result in an aggressive individual, though it may suggest an increased risk of aggression compared to a control population. Environment plays a significant role in modulating human behavior and instigating particular genetic pathways. While each cell has the same genetic code in an individual, different switches and stimuli alter the expression of those genes. While a nerve cell contains the same information as immune cell, it does not consume bacteria when it encounters it. To assume that a person is irredeemably violent based upon their genetic makeup is unfairly reductionistic and unethical (Rose, 1996).

Needle in the Haystack: Discovering Genetic Correlates

Neurogenetics, as a field, developed out of the work of individuals like Seymour Benzer, who demonstrated for the first time that fruit flies could be genetically altered to create animals with insomnia, learning disabilities, and homosexual courtship behaviors (Vosshall, 2007), thus, showing the connection between genetic mutations and brain function. In the intervening four decades, other insect studies, among other approaches, have broadened and deepened our understanding of neurogenetic pathways. For instance, the work of evolutionary biologist and ant scientist, E.O. Wilson, informed the development of *sociogenomics,* which seeks to achieve a comprehensive understanding of social life in molecular terms: "how [social life] evolved, how it is governed and how it influences all aspects of genome structure, genome activity, and organismal function" (Robinson, Grozinger, & Whitfield, 2005).

There are several techniques by which neurogeneticists assess the linkage between specific gene coding's and resulting behavioral and brain structure correlates. Chief among them are *twin studies,* which are commonly used within neurobiology and neuropsychology as well. The basis of twin studies is the recognition that twins, both identical and fraternal, share the same environment, but fraternal twins only share 50% of the same genetic material and identical twins, or monozygotic (MZ) pairs, share 100% of their genes and 100% of the shared environment. Thus, if identical twins "are significantly more similar on a characteristic than are DZ twins, then this phenotype (observed characteristics) is interpreted as being genetically influenced" (Koenen, 2007). Additional approaches include more complex molecular genetic studies such as *case-control gene association design* and *genome wide association studies (GWAS).*

Case-control gene association design detects genes with small effects on risk. Association studies "correlate a DNA marker's alleles, which are different sequences (SNP) of DNA at a specific position (or locus) on the chromosome, with an outcome" (Koenen, 2007). In case control studies, individuals with a given trait or disease are compared to a control group that do not phenotypically express the same trait or disease. *GWAS* is an examination of all or most of the genes (the genome) of different individuals of a particular species to see how much the genes vary from individual to individual. Different variations are then associated with different traits, such as diseases.