Autism and Social Engagement Behaviors:

The Copenhagen Interpretation, May 2003
With presentations by Stephen Porges, Sue Carter and Stanley Rosenberg

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On May 22-25, 2003, an historic convergence took place at the Stanley Rosenberg Institute in Copenhagen, Denmark. Leading practitioners of two quite different theoretical and therapeutic approaches to social engagement behaviors and related conditions demonstrated their discoveries before an inquisitive group of scientists, physicians, and therapists. The presentations, discussions, and demonstrations left us with a sense that a remarkable synthesis had taken place. The synthesis centered on the cranial nerves and the muscles of facial expression, vocalization, and listening, and the autonomic nervous system. A sense that a breakthrough had taken place emerged from the ways the principal presenters, Stephen Porges, Sue Carter, and Stanley Rosenberg, entered into a mutually appreciative and productive discussion with the other participants.

The outcome was optimistic because of the implications for treating individuals exhibiting a variety of atypical social behaviors such as autism. Optimism stems from the realization that in many cases the neural regulatory systems involved are intact. The Polyvagal Theory developed by Dr. Porges provides a plausible and logical understanding of the mystery of the behavioral features of autism and suggests specific neural circuits that may compromise spontaneous social engagement in a variety of psychiatric and behavioral disorders. Both Porges and Rosenberg described subtle non-invasive techniques can activate the part of the autonomic nervous system associated with the most evolutionarily advanced mammalian attributes of social engagement and bonding. Videos and other documentation revealed rapid and lasting changes in social behavior and communication.

Another reason for optimism came from moving discussions with formerly autistic individuals and their parents. Some of the disorders of social engagement, and their consequences, have been demystified. For example, a father of an autistic child feels a huge emotional loss because his daughter runs and hides when he speaks to her. She will not hug him. The diagnosis of autism "was like a death in the family," one father reported. The problem is not, as the father suspected, that his daughter does not love him. Instead, there is a lack of tone in two tiny muscles in the inner ear. Because these muscles are not functioning properly, the low tones of the father's voice are frightening and painful to listen to. And mothers often state, "My child's face does not work." The source of the problem is a lack of tone in the muscles of facial expression.

John's Story

Dr. Porges presented a video showing a 42-year old adult autistic participant whom we will call Bill, before, during, and after a treatment. The narration made during the video summarizes the story that will be detailed below.

> The video shows the results of Bill's experience in The Listening Project at the University of Chicago in Illinois. The Listening Project is a clinical trial of an intervention that uses acoustic stimulation. Dr. Porges called attention to the facial muscles to see how neurophysiological principles are being translated into interventions. This is "reverse engineering." It involves determining the mechanisms by which the autonomic nervous system works, including the various feedback loops, and applying that understanding to correct challenges to the social engagement system.
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> The tape begins before the intervention with Bill we see him talking on the phone with his sister. He is tense, has stiff neck muscles, and there is no movement of his upper face. In the video he is playing chess with his father, and he never looks up to address either parent; he keeps head down. His posture is almost like that of a blind person. He does not look at his mother at all. She says things to him, but he does not look at her.
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> He does not look at his father when his father attempts to make eye contact. There is no spontaneous eye contact or expression. Dr. Porges sees these as natural and predictable defense responses to stress that John has been experiencing for a long time.
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> During the intervention: It is music from the Chieftains. The music has been computer-modified in specific ways that are designed to activate the vagus nerve. (This will be described later).
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> Bill is moving his arms while listening. Day two, his face started to change. Note the smoothness of the facial muscles, especially around his eyes. Day 3, his face is starting to look more normal. As John listens to the acoustic stimuli, the frequencies in the recording are continuing to change. After the day-5 intervention, Stephen walks into room, and Bill turns, looks, smiles, makes eye contact, extends his hand, and says, "Dr. Porges."
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> The video includes several interviews with Bill after various phases of the intervention. After day 3: "I feel different, I can look at you and feel more natural. I am looking at all of you." He is seeking words to describe how he is feeling. It is hard for him to describe, but he feels more relaxed. While he can't express exactly what happened, he is able to sit in the room and feel comfortable. After day 5, his face looks and feels very different. He says that now his ears work without being bothered by low frequency sounds.

Bill months later: He is talking with his parents. He looks directly at them. He is looking directly at his father, smiling, talking. His eyes are looking more natural. His mom talks, and he turns toward her. They are discussing terrorism, and a terrorist bringing in an atomic bomb in a suitcase. He asks, "Is that true?" Someone asks, "What do you think?" He does not like the idea. His father asks, "In the last few months you have become a lot more communicative. That is nice isn't it?" Bill is moving his eyebrows. He is signaling with his eyebrows, and asks his father, "How are you?" He still pats his head from time to time, especially when he is anxious.

Back at the lab: Bill has big expressive wrinkles in his upper face that look like crow's feet behind his eyes. This is a sign of emotional exuberance and illustrates that his emotional expression is opening up. They discuss the suitcase bombing again. He thinks the idea is real. In the last few months, he has started talking about his father. Stephen asks, "How is your work going?" John responds, "Ok. I go to the library, and shelve books. I go to the country club and do fitness exercises; treadmill, I have worked myself up on the treadmill." He blushes when someone comes into the room, someone he knew, and he says that he "missed him." Bill is definitely becoming socially engaged, communicative, and comfortable with his family and others.

Polyvagal Theory

Professor Stephen Porges, of the Department of Psychiatry at the University of Illinois in Chicago, described his research on the autonomic nervous system, and the 'reverse engineering' of his discoveries for the treatment of autism and other disorders associated with deficits in spontaneous social behavior. Dr. Porges has published a series of widely cited scholarly research papers on his 'Polyvagal Theory.' This is an explanation of three neural systems that enable humans and other mammals to respond to their environments.

In 1921, Langley defined the autonomic nervous system as having two "motor" parts, the sympathetic or flight or fight system, and the parasympathetic, relating to nourishment and relaxation. Polyvagal theory recognizes a third branch, unique to mammals, that is involved in social interactions. The scheme is summarized in Figure 1.

Much of compromised human behavior, including the behavior of those who are diagnosed with psychopathologies such as autism, depression, aggressive disorders, post-traumatic stress disorder, or delayed speech, can be explained by adaptive shifts from one system to another. The key word, repeatedly emphasized by Dr. Porges, is 'adaptive.' None of the shifts are seen as bad or good, they are simply natural and automatic adjustments to the sensory environment, as the organism, given its traumatic history, interprets it. At any moment, all of us are functioning in one or more levels of Polyvagal neurology.

The social nervous system

What distinguishes mammals from other animals is a component of the nervous system that provides for calm 'social engagement,' including emotional expression, gesturing, looking, listening, vocalization, and bonding. This advanced evolutionary 'invention' enables us to enjoy our lives and our interactions with others, to smile and laugh and relate in ways that seem unavailable to the so-called 'lower' animals, such as fish and reptiles. Key to social engagement is the control of the muscles of the face and neck, which enable us to express a wide range of emotions in ways that others around us can detect, enjoy, and respond to. The nerves involved are the myelinated vagal motor fibers found only in mammals. Another key to comfortable social engagement is the innervation of two tiny muscles in the inner ear that protect the auditory system from loud low frequency sounds.

The sympathetic nervous system

The 'poly' aspect of Dr. Porges' work brings together the social nervous system and the other, evolutionarily older, branches of the autonomic nervous system. These neural networks are activated when we do not feel safe.

Our first reaction to danger is activation of the sympathetic nervous system, which takes us from socialization to 'fight or flight.' This state is characterized by the secretion of hormones that prepare our physiology for battle or rapid retreat, whichever seems to give us the best chance of safety or survival. Dr. Porges refers to this state as 'mobilization.' The blood supply shifts from the internal organs, such as the digestive tract, to the periphery, to the voluntary muscles of the limbs. Energetically, we are prepared to fight or run. The heart rate and blood pressure go up, the pupils dilate, the hair stands on end, and palms sweat. This system involves the unmyelinated vagal nerves that monitor and control the visceral organs such as the heart, lungs, and gut.

A single trauma or repeated and unresolved stress can lock a person into the 'flight or fight' state. People in this condition rarely smile, they are not having fun, and they are not socially engaged. In essence, they are constantly monitoring their environment and the people around them, primarily in a defensive mode. They are looking for the quickest 'escape route,' whether it be social, evasive, or combative. While such a physiological state is adaptive in some circumstances, it is not conducive to learning, problem solving, and maintaining social bonds.

The parasympathetic nervous system

In moments of extreme and hopeless danger or 'life threat,' the sympathetic or 'flight or fight' approach gives way to an even older nervous system. Activation of the parasympathetic nervous system shifts the circulation to the internal organs, protecting and nurturing the core of the body. Metabolic activity is depressed. Taken to the extreme, this system can cause us to shut down emotionally, faint, or feign death. A classic example is the mouse that has been caught by a cat. The mouse goes limp, as if it is dead. Should the cat lose interest in the seemingly lifeless mouse, and walk away, the mouse

gets up and scurries off to the nearest safe place. The most phylogenetically primitive neural circuit, the unmyelinated or 'vegetative' vagus, regulates this system.

New ways of looking at atypical social behavior

Dr. Porges has carefully mapped the neural connections involved in the three states, social engagement, danger, and life-threat. He has traced these connections back through evolutionary history (phylogeny). The result is a new way of interpreting compromised social behaviors found in several psychiatric disorders. Certain 'triggers' can cause the mammalian nervous system to reorganize in a predictable manner that limits social behavior. Polyvagal theory provides a logical way of looking at the neural circuitry involved.

While the scientific logic of this research is fascinating, what is even more striking is its application to autism and other so-called 'learning disorders.' On the basis of his research on the vagus nerve, Dr. Porges designed an intervention involving a particular kind of stimulation to the auditory system. He has tested this method on autistic children and autistic adults, and has had remarkable success. Watching videos of the subjects Dr. Porges and his colleague, Dr. Olga Bazhenova, have treated was an extraordinary and moving experience.

Stanley Rosenberg also had video documentation of successes with his methods, and was able to bring some of his subjects and their parents to the group to describe their experiences.

The Porges intervention

The intervention developed by Dr. Porges involves two tiny muscles within the middle ear. One of these muscles, the tensor tympani, is shown in Figure 2. The other muscle, shown in Figure 5, is the *stapedius*. Together, these muscles regulate the stiffness of the eardrum and the chain of bones (the ossicular chain) that conduct sounds to the inner ear. Proper operation of these muscles is essential in protecting the inner ear from very loud sounds, and for attenuating low frequencies so the higher frequencies of the human voice can be detected.

If the tiny muscles of the middle ear are not functioning properly, the nervous system is swamped with loud low frequency sounds. This has effects that are readily observable in autism. Hearing tests usually show that the ears are functioning normally. But the autistic individual has a tendency to cover their ears with their hands, or turn away from people who are speaking, because the sounds actually make their ears hurt. This is particularly the case for the low frequency sounds of the male voice. Parents, particularly fathers, take this behavior as a sign of rejection, and this can create a lot of stress in the family. However, the shift away from social engagement is predictable according to Polyvagal Theory, as ordinary sounds produce pain in the ears, one feels unsafe (Figure 1), the whole social engagement system is partly or completely shut down, and the sympathetic and parasympathetic systems are activated.

The intervention was tested in a blinded trial. The method involves playing computer-altered music to the subjects through headphones. The music is designed to stimulate the social engagement system. The sounds are enjoyable and engaging for the subject because a computer has removed the frequencies that are outside of the range of the human voice. In subsequent treatments, more and more frequencies are added, until the entire range of the human voice is present. Behaviors were assessed by parental questionnaires and by evaluating video recordings of a shared attention task. The trial revealed the effectiveness of the computer-altered sounds in increasing spontaneous social interactions. A three-month follow up study showed that the improvements persisted. This research is continuing.

The SRI Protocol

Stanley Rosenberg is the founder of the Stanley Rosenberg Institute, with schools in Silkeborg and Copenhagen, Denmark. Stanley Rosenberg has developed courses in Rolfing, facial massage, and cranial sacral therapy. Stanley is a long-time enthusiast of Dr. Porges' research, which has given him valuable tools to assess the condition of the nervous system during bodywork. Stanley has developed some unique approaches to stress, a widespread but poorly understood phenomenon with virtually no reliable physiological diagnosis or treatment protocols. The work of Dr. Porges has been invaluable in developing ways of diagnosing and treating stress.

In particular, there is a relationship between respiration and heart rate that can be used to assess the state of the autonomic nervous system. This is known as heart rate variability (HRV), a phenomenon well known in the medical community. Dr. Porges was one of the first scientists to explore HRV. Stanley Rosenberg has been a pioneer in exploring HRV in relation to hands-on bodywork.

From years of working with HRV and the muscles and nerves of the face and neck, Stanley has developed an understanding of how stress affects the body. He has also developed some gentle but powerful methods for diagnosing and treating stress. Stanley's work has led to gentle but very effective methods for treating eating disorders, asthma, whiplash, ear infections, psychological problems, and many other common issues. The most recent of Stanley's discoveries has proven to be a powerful set of techniques for treating autism.

For example, Stanley has discovered that the jugular foramen, through which the IX th, X th and XI th cranial nerves pass through the skull, can become distorted. If the bones and fascia in this region are under tension, these important nerves will be irritated. Diagnosis involves observing the tension in the left or right levator veli palatini muscle (IX th cranial nerve) and trapezius (XI th cranial nerve). A gentle treatment on the appropriate side, involving delicate cranial manipulation in the area of the jugular foramen, can resolve a wide range of physiological and emotional disorders.

During the conference it became clear that the cranial sacral technique Stanley Rosenberg has developed for treating stress, autism, and other disorders, differs significantly from the methods taught in other schools of cranial sacral therapy. Indeed, Stanley has realized

that many of the practitioners he has trained in the past do not know the latest thinking on the use of cranial sacral therapy for treating stress and autism. This gives rise to the possibility that some patients may seek out cranial sacral therapists under the mistaken assumption that these therapists will be able to treat autism. For this reason, Stanley Rosenberg has decided to distinguish his work on autism and related disorders by giving it a different name, and he is calling it the SRI Protocol.

The focus of Stanley's work is on the cranial nerves (Figure 3), the muscles of the face and neck, the openings in the skull where the cranial nerves exit (particularly the jugular foramen, see the white circle in Figure 3), and the top cervical vertebra, known as the atlas (Figure 4). Through conversations with Dr. Porges, over the last year, Stanley has developed a deeper appreciation of the neural regulation of the muscles of the face, neck, and mouth. This has enabled him to hone his methods for treating autism.

Sue Carter and the neurochemistry of human bonding.

Dr. Sue Carter is co-director, with Dr. Stephen Porges, of the Brain-Body Center at the University of Illinois at Chicago. Her research has explored the biology of social bonding. This was a valuable compliment to the other presentations. In essence, her work explores the biological necessity of the social nervous system that Stephen Porges has been studying.

The biologist can ask important questions, such as:

What is love?
What are social bonds?
Why are social bonds important?

Can a neuroendocrine system that uses a particular hormone, oxytocin, be used as a metaphor for understanding the role of love, social bonds and social support?

It is a biological fact that most living organisms cannot survive or reproduce alone.
The mammalian nervous system is designed to work in a social environment. Social behavior is necessary for physiological and behavioral homeostasis. For example, Harry Harlow's studies showed that putting young animals alone in cages was a disaster. This research was going on at the same time that humans were putting babies in cribs. In the absence of appropriate social interactions and social bonds (i.e. isolation) substitutions may occur: abuse of drugs, abuse of food, mental dysfunctions, etc.

What is love? From a scientific perspective, is love a measurable emotion or emotional state? Does love consist of biological processes, and is it based on universal needs? If this is true, then we can study love, as we do other aspects of biology and behavior.

Social attachment is a common feature of most definitions of love. It is our system of negotiation on closeness. But social attachment is not limited to humans.

Precisely what are social bonds? Social bonds are hard to define, but however they are defined, social support and social bonds are associated with better mental and physical health (Uchino et al 1996; Singer & Ryff, 2001). For example, following a myocardial infarction, patients with more social support are more likely to survive.

Birds and mammals have different bonding processes. The mother-infant bond is special to mammals. Baby birds can survive without their mothers.

The Prairie Vole, *Microtus ochrogaster*, is particularly useful for researching monogamy, social bonds, and their physiological origins. Dr. Carter has worked on voles with a number of collaborators. Voles have comparable behavior in nature and in the laboratory, which makes them a convenient model for studying the hormonal aspects of bonding.

Voles show social monogamy. They show high levels of social contact, pair bonding, mate guarding, bi-parental care of young, and willingness to fight off strangers.

What are social attachment and social bonding? Scientifically they are described as a powerful form of learning regulated by long-lasting changes in the endocrine systems and brain. The hormone, oxytocin, is integral to the neural pathways for social behavior. Oxytocin is released during and facilitates birthing, lactation, sexual behavior, etc.

Knowledge of the neuroendocrinology and neuroanatomy of peptide hormones including oxytocin suggests mechanisms through which social behavior relates to homeostasis. Fear and safety are intertwined with social processes. Oxytocin is particularly useful in understanding social behavior.

Sexual behavior facilitates pair bonding in prairie voles. Oxytocin is released by sexual behavior. Hypothesis: oxytocin plays a role in pair bond formation. This has been demonstrated experimentally. If voles are given oxytocin after sex, they get strongly bonded.

Oxytocin does not act alone, for example oxytocin has a sibling hormone, arginine-vasopressin.

There is little research on human social bonding. In one study, rats were handled in early life and were exposed as adults to a cancer inducing substance. Animals with early handling had half the tumors compared with those without handling. Something in early life can change your vulnerability to disease later on.

The attachment system is there whether we want it or not. ‘Don’t feel these emotions,’ is not an option. These are pre-cortical, wired-in systems. Stressful life experiences enhance social attachment. People in stress come to therapists when they need bonding. They are set up for bonding.

Stephen suggested an answer to the question, ‘What is love?’ Love, he suggested, is immobilization without fear. This is what is happening when people come for therapy.

Mammals are very selective about who they allow to touch them. The visit to the therapist is a submissive behavior. Oxytocin is a peptide of bonding, love, birthing, etc., and it allows the body to be immobilized without fear. It is part of the feedback system regulating the old unmyelinated vagal system. Oxytocin enables the old immobilization system to be utilized for a special reason.

The convergence

The therapeutic approaches, developed by Porges and Rosenberg, and complemented by Sue Carter, are superficially entirely different, but they converge around a theory of social engagement and facial expression that has enormous implications for the treatment of autism and other so-called 'learning disabilities.' The magnitude of the development arises from the opportunity to explain and resolve a seemingly hopeless situation for which medicine has previously had little to offer in either theory or treatment.

The important biology demonstrated at the conference centers around the intricate feedback systems, mediated via the cranial nerves that connect the brain and the muscles of social engagement. These feedbacks are very responsive to subtle interventions, and the entire system can be activated. The entire cranial innervation, both sensory and motor, via the 12 cranial nerves (Figure 3), can now be seen as an intricate and dynamically interconnected network that serves the uniquely mammalian functions of social engagement and bonding. The emphasis is on the special visceral efferent pathways that are part of the 5 cranial nerves (V, VII, IX, X, XI) that evolved to regulate the structures associated with the ancient gill arches. These neural pathways regulate the striated muscles of the face and head. Interestingly, in the brainstem the nuclei regulating these muscles are neuroanatomically and neurophysiologically linked to the myelinated vagus.

Normal social engagement is poised for spontaneous emergence, once some of these systems are activated. This appears to be a classical example of a non-linear system in which attention to any one component can trigger effects on the entire network and stimulate the socialization processes. The interventions described by Porges and Rosenberg lead patients to a greater sense of safety, opening up opportunities for them to become more comfortable with social engagement. Autism and related problems are now logically definable with reference to specific neuromuscular pathways that present in all animals but that have an organization that is unique to mammals. It is a system that is essential to the 'higher' functions such as learning, problem solving, and maintaining social interactions and bonds.