Safe and Sound

A Polyvagal Approach for Connection, Change, and Healing

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Supplemental PDF

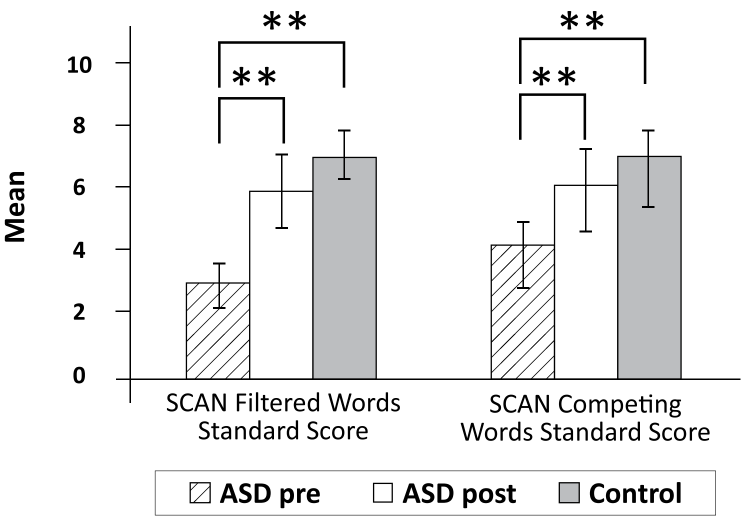
Chapter 2

The Safe and Sound Protocol: A Groundbreaking Polyvagal Approach

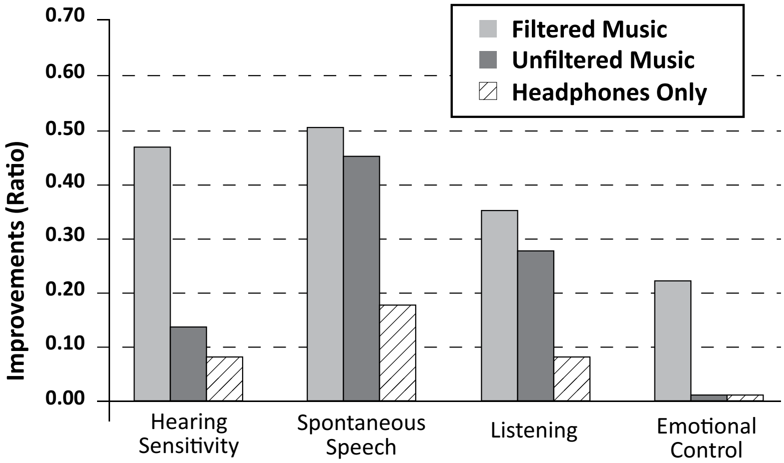
Laboratory and Peer-Reviewed Research Summary Through Charts, Tables, and Graphs

SSP Improves Auditory Processing

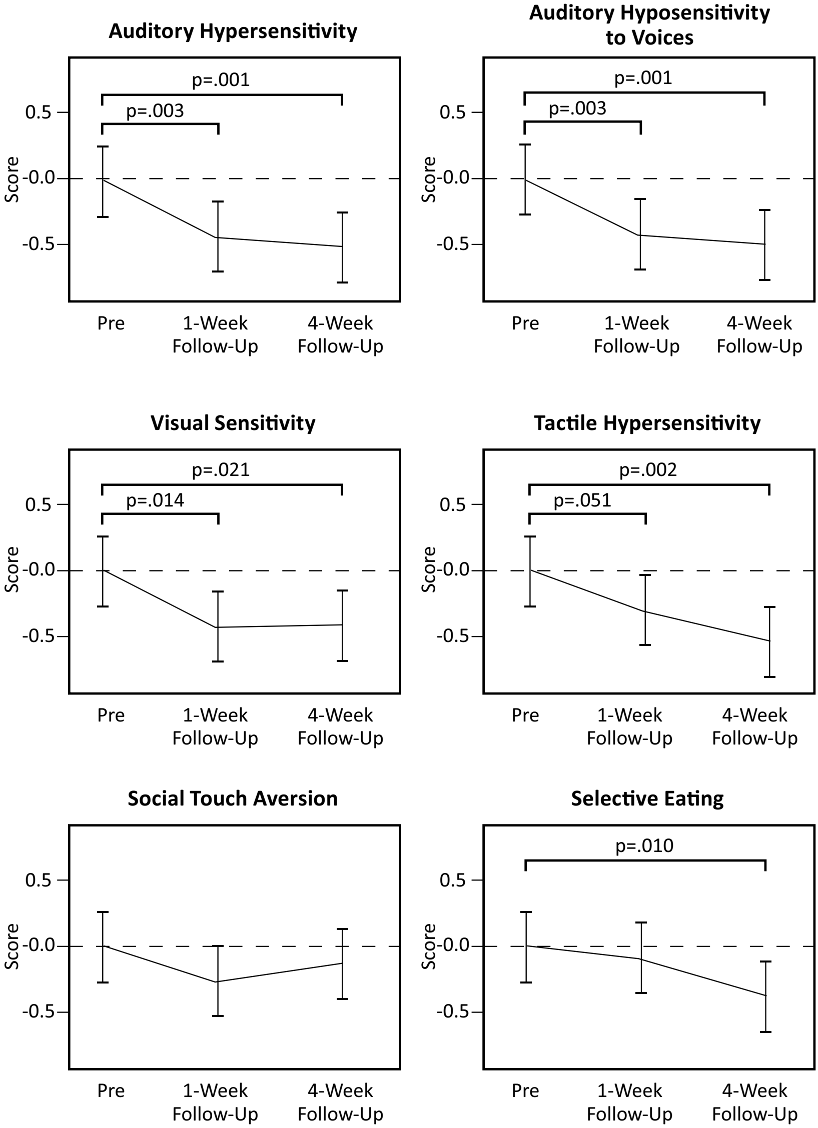
*SCAN standard scores for ASD participants before and after intervention compared to performance of control participants. Error bars represent +/− two standard errors of the mean. ** = p < .01.*



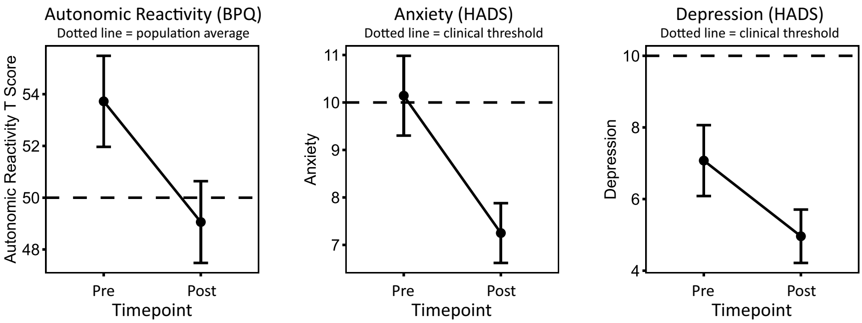
SSP Improves Hearing Sensitivity, Spontaneous Speech, Listening, and Emotional Control



SSP Improves the Regulation of Hypersensitivities in Autistic People



SSP Improves Measures of Autonomic Reactivity, Anxiety, and Depression



SSP Improves Social Engagement Behaviors and Physical Movement and Supports the Reduction of Symptoms of Functional Neurological Disorder

Pre- and Post-Treatment Measures of the Depression, Anxiety, and Stress Scales (DASS) and the Body Perception Questionnaire (BPQ)

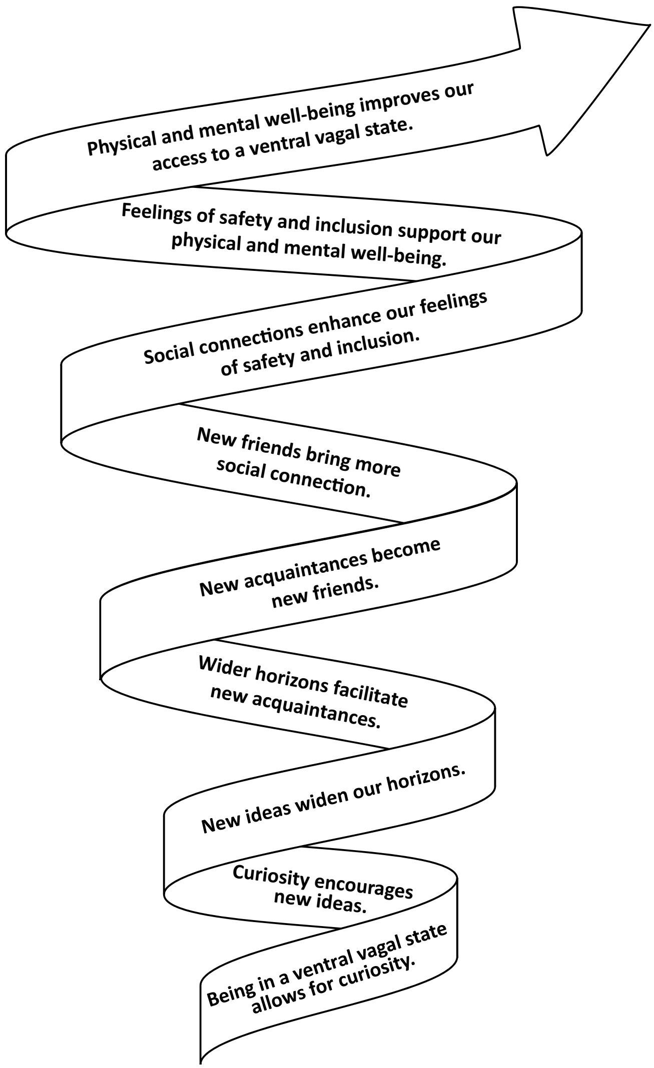
	Measure & Domain	**Pre-SSP**	**1 Month Post-SSP**
Depression, Anxiety & Stress Scales		Clinical Range	Normal Range
	Depression Scale	**18**	**2**
	Anxiety Scale	**21**	**1**
	Stress Scale	**17**	**8**
	Total DASS Score	**56**	**11**
Body Perception Questionnaire		Clinical Range	Normal Range
	Body Awareness (T-score)	**63.4**	**42**
	Supradiaphragmatic Reactivity (T-Score)	**70.6**	**43.7**
	Subdiaphragmatic (Gut) Reactivity (T-Score)	**72.8**	**36.6**

Real-World Evidence

Assessment	Function	Sample Size	Improved	Clinical → Non-clinical	T-value	Significance Level
GAD-7	Anxiety	313	86%	61%	21.8	p<.00001
PHQ-9	Depression	208	81%	54%	10.7	p<.00001
PCL-5	PTSD	120	91%	63%	13.7	p<.00001
PSC	Psychosocial Function	94	83%	47%	8.0	p<.00001

Self-Directed Change and Healing: Retuning the Nervous System

Consider the following example of an upward spiral. It illustrates how small, incremental steps can lead to lasting changes:



The Regulation Toolbox: Self-Directed Activities for Regulation by ANS State

VENTRAL VAGAL REGULATION TOOLBOX

Recognize Your Physiological State

Metaphor: We are in an inflatable boat—buoyant, easy to maneuver, and able to remain stable despite the wind and the waves.

Description: "We are floating."

Color: Green

Create Awareness of Your Physical Sensations

- Activated facial muscles—especially in the cheeks for smiling and around the eyes
- Warm/calm feeling in stomach
- Sense of body alignment and integration from head to toe
- Fluid movement
- Relaxed muscles
- Buoyant but grounded feelings
- Steady heart rate
- Elevated HRV
- Even breathing
- Positive energy
- Acute hearing
- Clear, prosodic voice

Acknowledge Your Thoughts, Emotions, and Behaviors

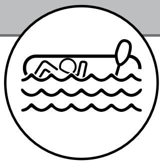
- Capable of compassion and understanding
- Calm and connected
- Aware and thinking clearly
- Present and "ready"
- Flexible
- Less concerned about the opinion of others and less negative in self-talk
- Mindful and embodied
- Able to access higher thinking processes and impulse control
- Creative, flexible, and playful
- Social
- Adaptable to change
- Open
- Bold—willing to take risks
- Able to think abundantly
- In awe

Activities for Regulation in a Ventral Vagal State

- Savor the feeling!
- Journal about what preceded this state so you can access it again more easily
- Connect and co-regulate with friends
- Appreciate the evenness of your breathing
- Stretch and welcome the freedom of movement
- Vocalize: hum, sigh, sing, whistle, laugh, play a wind instrument
- Move, walk, dance
- Meditate
- Listen to music that delights you
- Experience nature and what inspires you
- Engage in creative activities
- Activate your senses

SYMPATHETIC REGULATION TOOLBOX

Recognize Your Physiological State



Metaphor: We have tipped out of the boat and are actively struggling against the waves and currents.

Description: "We are flipping out."

Color: Red

Create Awareness of Your Physical Sensations

- Elevated heart rate
- Constricted breathing
- Lower HRV
- Anxious feelings
- Muscle tension
- Tight chest and throat
- Heightened arousal
- Restlessness
- Jitteriness
- Loss of integrated sense in body
- Disorganization
- Digestion difficulties
- Sleep difficulties
- Headaches
- Sweating
- Difficulty discerning speech; muted hearing
- Loud, tense, or shaky voice

Acknowledge Your Thoughts, Emotions, and Behaviors

- Anxious and insecure
- Focused on self, not others
- Hypervigilant
- Agitated
- Reactive (not responsive)
- Angry
- Thinking in black and white
- Unable to concentrate
- Experiencing racing thoughts
- Impulsive
- Irritable and confrontational
- Unable to think critically
- Overeating/overdrinking/ overexercising
- Confrontational
- Fearful
- Sensitive to the perceived opinions of others
- Unable to connect with others

Activities for Regulation in a Sympathetic State

- Practice calming breathwork: extend or vocalize your exhale
- Practice Hand-on-Heart
- Vocalize: growl, sigh, hum, extend your phrases
- Practice Body sensing/scanning
- Notice areas of tension
- Practice progressive muscle relaxation
- Massage jaw and neck
- Move, shake, dance
- Practice Stanley Rosenberg's Basic Exercise
- Meditate
- Try something playful
- Connect and share with a friend
- Find humor
- Recall calming memories
- Feel comfort
- Practice the Valsalva Maneuver
- Experience nature and what calms you
- Practice Child's Pose
- Practice Box Breathing
- Practice Soothing Butterfly Hug
- Practice Simplified Self-Havening
- Practice Healing Head Hold
- Listen to calming music

DORSAL VAGAL REGULATION TOOLBOX

Recognize Your Physiological State

Metaphor: We have sunk under the waves to seek protection and avoid the turbulence of the water's surface.

Description: "We are flopping down."

Color: Gray

Create Awareness of Your Physical Sensations

- Slow heart rate
- Shallow breathing
- Hollow stomach
- Slow movement, sedentariness
- Heavy body
- Hunched posture
- Low energy
- Dull, flat feelings
- Low gut motility
- Fatigue
- Oversleeping
- Dizzy
- Weak
- Nausea
- Muted hearing; difficulty discerning speech
- Monotone voice devoid of emotion or energy

Acknowledge Your Thoughts, Emotions, and Behaviors

- Disconnected
- Avoidant
- Numb
- On "auto pilot"
- Having difficulty remembering and concentrating
- Feeling flat emotionally
- Feeling negative
- Catastrophizing
- Ruminating
- Low on motivation
- Lacking creativity
- Overwhelmed
- Apathetic
- Hopeless
- Avoidant
- In a mental fog
- Having difficulty connecting with others

Activities for Regulation in a Dorsal Vagal State

- Be gentle with yourself
- Vocalize: groan, sigh, sing, hum
- Move, shift posture, stretch, wiggle fingers and toes, walk, rock, or sway
- Massage face, hands, and feet
- Practice activating breathwork, such as humming and bee breathing
- Experience nurturing sensations
- Take a shower or bath
- Wrap yourself in a blanket (even a weighted blanket)
- Massage your head
- Hug a pillow or a soft toy
- Recall a supportive connection with a friend; consider reaching out to them
- Experience nature and feel the sun, rain, or wind
- Listen to music you're drawn to
- Practice Stanley Rosenberg's Basic Exercise
- Practice Cat/Cow for awakening the body
- Practice Healing Head Hold
- Practice the Cross Crawl/Cross Over Shoulder Pull

Video Demonstrations for Strengthening Autonomic Resilience

In any moment, we are our autonomic state because our state is the platform for all of our sensations, thoughts, emotions, and behaviors.

Understanding the organization and tendencies of our individual nervous system is the first step to strengthening autonomic resilience. By recognizing the bodily sensations, thoughts, emotions, and behaviors associated with each of our physiological states, we become more attuned to our nervous system. As this awareness grows, we can actively engage in co-regulation and participate in regulating exercises and activities, fostering autonomic flexibility and resilience.

Repeated experiences of nervous system disruptions and subsequent repairs, whether through co-regulation or self-regulation, contribute to building autonomic resilience. With practice, we can guide our ANS toward safety and connection and relearn autonomic balance.

The following practices have been contributed by colleagues and friends in the polyvagal community to help us gradually retune our autonomic responses, enhancing both fluidity and resilience.

Access these video guides at soundstrue.com/safe-and-sound-bonus.

- Deb Dana, LCSW, rhythmofregulation.com
  - Glimmers are micro-moments of regulation that foster feelings of well-being. When we notice and name glimmers, we shape our system toward regulation. This practice helps you to see, stop, and appreciate glimmers as a way of shaping your nervous system toward regulation.

- Arielle Schwartz, PhD, drarielleschwartz.com
  - Engage your vagus nerve naturally by exercising your eye muscles with Stanley Rosenberg's Basic Exercise. In his book The Healing Power of the Vagus Nerve, Rosenberg describes how moving your eyes can relax the occipital muscles, increasing blood flow to the brainstem and vagus nerve. Try eye exercises and neck stretches to experience these benefits firsthand.

- Betsy Polatin, MFA, SEP, AmSAT, humanual.com
  - Two practices will be demonstrated. The Humanual Polyvagal Smile is an experiential exploration integrating the ventral vagal system with muscular, respiratory, and fascial systems, inviting awareness, discovery,

and movement. The Exploration of Support considers the universal forces of gravity and antigravity and helps you connect to the ground and expand into your environment.

- Jan Winhall, MSW, IPFOT, janwinhall.com
    - The Felt Sense Polyvagal Grounding Practice is the foundational embodiment practice used in the Felt Sense Polyvagal Model. The practice teaches the two main embodied processes of interoception (felt sense) and neuroception (PVT).

- Jill Miller, C-IAYT, author of Body by Breath and The Roll Model and cofounder of tuneupfitness.com
    - Jill demonstrates three zones to stimulate the vagus nerve and access areas of the body to aid in increased downregulation through breath and myofascial self-massage.

- Rebecca Bailey, PhD, LP, polyvagalequineinstitute.com
    - Co-regulation is evident in many human-animal interactions. Self-regulation and slowing down are essential to connection, yet they often require practice and the courage to connect. Horses are particularly aware of subtle communications of safety and bids for connection. In this brief video, you will see the communication in action between horse and human. The background music is from Hour 1 of SSP Connect: Classical Flow.

- Amber Elizabeth Gray, PhD, ambergray.com
    - The Yielding to Rise moving practice is an invitation to experience the dynamic range of neuro-physiological states—the literal dance of our vagal circuitry. Incorporating contemplative movement, somatic awareness, and more dynamic movement, this tiered practice will be shared in a way that is inclusive of all bodies and movement abilities.

- Donnalea Van Vleet Goeltz, PhD, continuummovement.com
    - Breathing techniques and movement help shift both physiological and psychological states. This approach combines education and experiential learning based on polyvagal theory and is currently being researched at University of Florida Health.

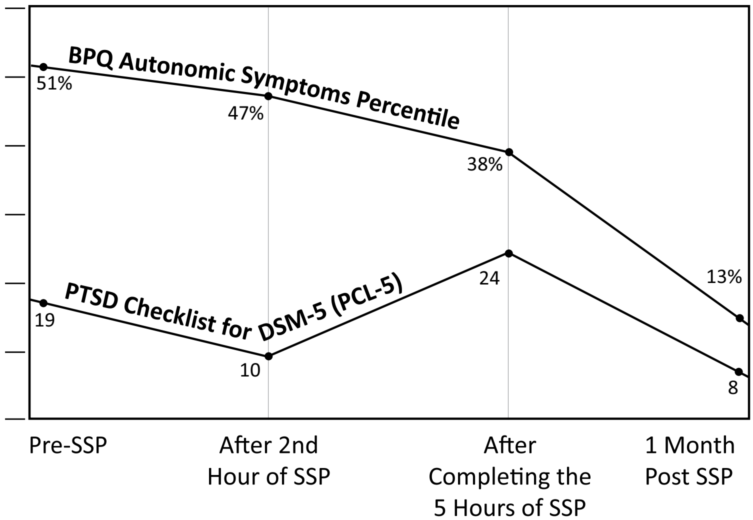
- Linda Chamberlain, PhD, MPH, GCFP, C-IAYT, drlindachamberlain.com
    - Four simple tools for helping children calm their nervous system and emotions will be demonstrated. Two of these tools are featured in Howling with Huskies along with other resources. These techniques are easy to use on the go and work for people of all ages.

Chapter 9

Uwase's Recovery from Disabling Dissociation

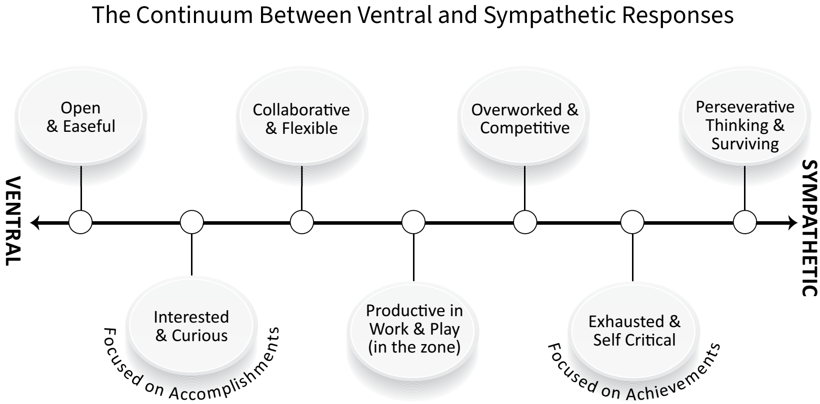
Assessments

Body Perception Questionnaire and PCL-5 Results



Chapter 11

Shifting from Perfectionism to Being "Perfectly Imperfect"



Appendix 1

Assessment Descriptions

Autonomic Resilience Screener

The Autonomic Resilience Screener (ANS Screener) is a subjective questionnaire developed by a group of SSP providers aiming for an efficient tool to gain insights into their clients' ANS in a comprehensive and inviting manner. The screener comprises six sections: emotions, body, sensory, behavior, cognitive, and social. This tool is designed to bring clinical attention to relevant experiences during SSP delivery, facilitating the process of delivery, titration, response tracking, and change measuring post-SSP.

Behavior Assessment System for Children

The Behavior Assessment System for Children third edition (BASC-3) is a comprehensive set of standardized, norm-referenced tools designed to assess the behavior and emotional functioning of children and adolescents. The BASC-3 is widely used in educational, clinical, and research settings to identify behavioral and emotional challenges, assess treatment progress, and inform goal setting and treatment planning.

Body Perception Questionnaire Autonomic Symptoms Scale

The Body Perception Questionnaire Autonomic Symptoms Scale (BPQ20-ANS) is a standardized self-report questionnaire that assesses the frequency of specific body stress reactions in organs that are innervated by the ANS. Though each unique part of the body may have its own reason for activation, the parts are linked by the ANS, a brain-body network that responds to everyday stress. Combined scores from organs throughout the body provide a measure of autonomic stress response patterns. The questionnaire has been used in a range of international neural, behavioral, and clinical studies and translated into more than a dozen languages and has been corroborated with sensor-based measures of autonomic function assessed at the laboratory at Indiana University.[1] The BPQ20-ANS is available from the Traumatic Stress Research Consortium at Indiana University (traumascience.org/body-perception-questionnaire).

Brain-Body Center Sensory Scales

The Brain-Body Center Sensory Scales (BBCSS) is a self-report questionnaire based on PVT that links cranial nerve feedback and regulatory mechanisms to behavior. The adult and child versions include questions across four subscales: auditory processing, visual processing, tactile processing, and eating and feeding behaviors. More information is available from the Traumatic Stress Research Consortium at Indiana University (traumascience.org/bbcss-self-scoring-form).

Hospital Anxiety and Depression Scale

The Hospital Anxiety and Depression Scale (HADS) was developed as a self-assessment scale for detecting states of depression and anxiety in people who are receiving medical treatment. It consists of 14 items, divided into two subscales: one for anxiety symptoms and one for depression symptoms. The HADS is widely used in clinical settings to screen for anxiety and depression among patients with physical illnesses.

Minnesota Multiphasic Personality Inventory-2

The Minnesota Multiphasic Personality Inventory-2 (MMPI-2) is a widely used psychological assessment tool that measures various aspects of an individual's personality and psychopathology. It is designed to assist in the diagnosis, treatment planning, and research of mental health conditions.

Parkinson's Disease Questionnaire

The Parkinson's Disease Questionnaire (PDQ-39) is a widely used self-report assessment tool designed to measure the health-related quality of life in individuals with Parkinson's disease. It evaluates various aspects of daily functioning, emotional well-being, and social interaction that may be affected by the condition.

Patient Health Questionnaire-9

The Patient Health Questionnaire-9 (PHQ) is a self-assessment tool used to screen and assess the severity of depression symptoms.

Pediatric Symptom Checklist

The Pediatric Symptom Checklist (PSC) is a brief, standardized tool designed to screen for emotional, behavioral, and cognitive issues in children and adolescents. It consists of questions that address emotional and behavioral concerns, attention problems, and social difficulties.

PTSD Checklist for DSM-5

The PTSD Checklist for DSM-5 (PCL-5) is a widely used self-report measure used to assess symptoms of post-traumatic stress disorder (PTSD) based on the diagnostic criteria outlined in the fifth edition of the Diagnostic and Statistical Manual of Mental Disorders (DSM-5).

Quantitative Electroencephalography

The Quantitative Electroencephalography (qEEG) is a type of brain imaging analysis that involves the measurement of electrical activity in the brain. Unlike traditional electroencephalography (EEG), which records brain wave activity in a qualitative manner, qEEG provides a quantitative analysis of the data. This allows for a more detailed assessment of brain wave patterns, including the frequency, amplitude, and distribution of electrical activity across different regions of the brain. In clinical settings, qEEG has been employed to aid in the diagnosis and treatment planning for conditions such as epilepsy, ADHD, and other neurological and psychiatric disorders.

SCAN-3 Tests for Auditory Processing Disorders

The SCAN-3 Test for Auditory Processing Disorders (SCAN-3:C for children) and (SCAN-3:A for adults) is an assessment tool used to evaluate individuals for auditory processing disorders (APD). APD refers to difficulties in processing and interpreting auditory information, even though the person's hearing may be normal.

SSP Behavioral Symptoms Pre- and Post-Test

The SSP Behavioral Symptoms Pre- and Post-Test is used to evaluate changes in behavioral symptoms before and after undergoing the SSP intervention. Participants or their caregivers are asked to provide information about symptoms, such as hypersensitivities, communication challenges, emotional dysregulation, attention difficulties, and social engagement issues. The assessment helps track progress and provides valuable information for treatment planning, monitoring outcomes, and making adjustments to the intervention if needed.

SSP Intake Form

The SSP Intake Form is a document used to initiate a conversation about the client. It collects information about the individual's history, sensory sensitivities, autonomic tendencies, home environment, access to supportive people and resources, upcoming stressful experiences, and their specific concerns or goals related to participating in SSP. Not an assessment per se, the SSP Intake Form is the start of an autonomic conversation between the provider and client.

Appendix 2

Short- and Long-Term Effects of Autonomic Dysregulation on Various Bodily Systems

Cardiovascular System

- Short term: Changes in heart rate, blood pressure, and blood vessel dilation may result in symptoms such as palpitations, lightheadedness, dizziness, or fainting
- Long term: Orthostatic intolerance (difficulty maintaining blood pressure when changing positions), tachycardia (persistent elevated heart rate), high blood pressure, and dysautonomia

Respiratory System

- Short term: Breathing patterns may be affected, changing respiratory rate and depth and causing rapid or shallow breathing
- Long term: Dyspnea (shortness of breath/gasping for air), hyperventilation syndrome

Gastrointestinal System

- Short term: Disruptions in digestion may lead to nausea, abdominal pain, bloating, constipation, and diarrhea
- Long term: Dysmotility, or impaired movement of the digestive tract, leading potentially to gastroparesis or irritable bowel syndrome

Metabolic Function

- Short term: Impacts on energy metabolism and the balance of glucose and insulin in the bloodstream
- Long term: Metabolic disorders, insulin resistance, high blood pressure

Temperature Regulation

- Short term: Disruptions in temperature regulation, leading to sensations of overheating or excessive sweating
- Long term: Hypothermia and hyperthermia, which could lead to organ failure

Musculoskeletal System

- Short term: Changes in muscle tone and tension can occur, contributing to symptoms such as muscle stiffness, pain, or tremors
- Long term: Myofascial pain syndrome, chronic pain syndrome

Endocrine System

- Short term: Hormonal imbalance affecting metabolism, sexual function, reproduction, disruption of sleep-wake cycle, and mood
- Long term: Infertility, diabetes, thyroid disease, sexual dysfunction, obesity, depression, anxiety

Immune System

- Short term: Disruption of immune response, potentially impacting susceptibility to infection or autoimmune conditions
- Long term: Autoimmune disorders, increased risk of cancer, damage to the heart, lungs, nervous system or digestive tract

Cognitive Function

- Short term: Brain fog, poor access to executive functions leading to difficulties with concentration, memory, and impulse control
- Long term: Impulsivity, lack of motivation, fatigue, insomnia, mood disturbances

Emotional and Mental Health

- Short term: Mood swings, anger outbursts, anxiety, depression, disrupted sleep patterns, difficulty connecting with others
- Long term: Major depressive disorder, insomnia, panic attacks, chronic loneliness, self-harming behaviors, eating disorders, substance abuse

Multiple Systems

- Short term: Decreased energy, fatigue, inflammation, frequent illness, frequent headaches
- Long term: Chronic fatigue, fibromyalgia, multiple chemical sensitivity, functional neurological disorders, noncardiac chest pain, chronic pelvic pain, chronic inflammatory diseases

Appendix 3

Personalized Regulation Toolboxes

Create your own personalized Regulation Toolbox as described in chapter 4 by adding favorite activities and personalized descriptions of your autonomic states.

Recognize Your Physiological State

Draw your own icon

Metaphor:

Description:

Color:

Create Awareness of Your Physical Sensations

Acknowledge Your Thoughts, Emotions, and Behaviors

Activities for Regulation in a Ventral Vagal State

Recognize Your Physiological State

Draw your own icon

Metaphor:

Description:

Color:

Create Awareness of Your Physical Sensations

Acknowledge Your Thoughts, Emotions, and Behaviors

Activities for Regulation in a Sympathetic State

Recognize Your Physiological State

Draw your own icon

Metaphor:

Description:

Color:

Create Awareness of Your Physical Sensations

Acknowledge Your Thoughts, Emotions, and Behaviors

Activities for Regulation in a Dorsal Vagal State

Appendix 4

Polyvagal Insights

The following polyvagal insights illustrate PVT in action. By viewing the world through a polyvagal lens, we gain a more compassionate and optimistic perspective on our lives and how we live them. Polyvagal insights highlight the influence of safety or threat in all areas of life and relationships. These influences are evident in our own behaviors and those of others, offering valuable perspectives and guidance in areas like parenting, teaching, medicine, employee development, coaching, therapy, and essentially any human interaction.

In each case story, these insights are denoted in footnotes, identifying the specific polyvagal insights as they appear.

Polyvagal Insight 1: Autonomic State Functions as an Intervening Variable

Autonomic state serves as a platform for our thoughts, feelings, and behaviors, acting as an intervening variable between the world and our response to it. Unlike traditional learning models that focus on stimulus-response associations, PVT emphasizes the role of autonomic state in shaping these associations and frames how we interpret situations and respond. Our autonomic state can increase or decrease our reactivity to events and stimuli thereby framing the same events or stimuli with a different story.

For example, in a dorsal vagal shutdown state, an event may cause feelings of overwhelm and withdrawal. In an activated sympathetic state, it might cause anxiety and agitation. However, in a ventral vagal state, the very same event can evoke curiosity and openness, and even a potentially negative stimulus may not be upsetting.

Through a polyvagal lens, our responses and behaviors are not intentional or shaped by rewards and punishments. Instead, they are part of an adaptive, reflexive system wired into our nervous system, influencing our thoughts, feelings, and behaviors beyond our full voluntary control.

Understanding this helps us develop greater self-awareness and cultivate empathy for others' behaviors. Recognizing the impact of our autonomic states can help interrupt a downward spiral and even initiate an upward one.

When we feel safe, our nervous system is primed to interpret interactions positively, leading to improved communication, reduced misunderstandings, and greater empathy and compassion.

Polyvagal Insight 2: Autonomic States Bias Our Feelings, Thoughts, and Behaviors

Although described as distinct, autonomic states exist on a continuum, subtly influencing our sensations, emotions, thoughts, and behaviors.

In a ventral vagal state, we feel a sense of welcome, connection, and creativity. Blended states like play, flow, quiet connection, and intimacy incorporate the SES. When threats arise, defensive states are triggered. A sympathetic state brings increased activation and hypervigilance, often hindering authentic connection and executive functioning. Blended states involving sympathetic input include play, flow, productivity, and freeze. In a dorsal vagal state, individuals may experience overwhelm, numbness, and shutdown. Blended states with dorsal vagal input are moments of quiet connection and intimacy, rest and restoration, and freeze.

Cues of safety from our surroundings, relationships, and SSP help the ANS reengage in a ventral vagal state, supporting homeostatic functions and fostering greater calm and connection. This state enhances our emotional regulation and ability to navigate social interactions while also helping us understand the nuances of our states and tendencies. As a result, we can communicate more effectively, anticipate our needs, and take better care of ourselves.

Polyvagal Insight 3: Neuroception Detects Cues of Threat and Safety and Alters Autonomic State

Neuroception operates swiftly and unconsciously, detecting cues of safety, danger, or life threat from internal, external, or relational sources. This reflexive process instantaneously shifts autonomic states to support adaptive survival responses. While we may not consciously perceive the inputs to neuroception, we do notice its outputs through bodily changes like shifts in heart rate, breathing, and muscle tension.

Shaped by life experiences, neuroception can sometimes lead us to detect threats where none exist or overlook real dangers. Accurate detection and interpretation of neuroception are crucial for our survival and well-being.

Awareness of our neuroception empowers us to make informed choices. By structuring our environment with more cues of safety and minimizing situations and people that trigger a neuroception of threat, we can enhance our overall sense of security.

Polyvagal Insight 4: The Power of Social Connection and Co-Regulation

Social connection and co-regulation are fundamental human needs, essential for our health and well-being. Co-regulation, facilitated by the activation of the SES, involves a mutually regulating interaction where both individuals feel valued, heard, and in sync.

The cues exchanged between individuals—such as eye contact, facial expressivity, and vocal tone—are reciprocal, influencing and regulating the nervous systems of both parties. Cultivating co-regulating relationships fosters feelings of safety and connection, which, in turn, enhance our ability to develop self-regulation skills. When we feel safe, we can engage socially, forming new connections and deepening existing relationships.

The ability to regulate another's nervous system alongside our own through co-regulation provides invaluable support during times of stress. This cultivates emotional resilience, deepens trust, and allows for the de-escalation of difficult situations, promoting collaboration. As a result, we become better communicators and feel more understood and connected.

Polyvagal Insight 5: Autonomic State Impacts Social Cues

Our nonverbal social cues broadcast our current autonomic state, reflecting how we feel internally and influencing our interactions with others. The five cranial nerves of the SES work together to coordinate the tone and tempo of our voice, eye contact, facial expressions, auditory processing, head and neck movements, and heart rate regulation.

These nonverbal cues can change significantly depending on our autonomic state. In defensive states, expressivity often diminishes, facial tension increases, and our voice may become louder, higher or lower in pitch, or monotone. We might also shake our head or avert our gaze, signaling disagreement or disinterest. Conversely, in a ventral vagal state, these cues soften, becoming more open, warm, modulated, and relaxed.

Not only do our social cues reflect our own autonomic state, but they can also influence the autonomic state of others.

Polyvagal Insight 6: Autonomic State, Vocal Intonation, and Middle Ear Muscle Regulation Mutually Influence Each Other

The mutual influences among autonomic state, intonation of voice, and the regulation of our capacity for auditory perception has broad implications.

In states of threat, our middle ear muscles loosen and prioritize low and high frequencies associated with danger, potentially keeping us locked in a state of threat. Defensive states will also affect the quality of our voice, shifting it to have less prosody and be higher pitched, signaling distress. In a ventral vagal state, those muscles tighten, dampening low frequencies and enhancing the perception of human voices. Our own voice becomes warmer, more melodic, and modulated, conveying ease and engagement.

Our soundscape and the voices of people we spend time with will affect our state. And our state will also affect what we can hear and what we tune out.

Polyvagal Insight 7: The ANS Can Be Retuned to Prioritize Connection and Well-Being

The brain naturally forms and strengthens neuronal connections through neuroplasticity as new concepts are learned. Similarly, the brainstem's regulation of the ANS is neuroplastic, allowing for autonomic responses to be retuned.

Practices in self-regulation, like SSP and other modalities that emphasize the brain-body connection, can enhance this ability for change. Transitioning repeatedly from a defensive state to a connected, ventral vagal one enhances autonomic resilience. By flexibly and appropriately shifting along the continuum of autonomic states, we increase our access to social connection and overall well-being.

Polyvagal Insight 8: The ANS Is at the Core of Our Physical and Mental Wellness

Our physical and mental health thrive when our ANS is in a state of safety, which optimizes homeostatic processes that support healing and recovery.

The brain, nervous system, and visceral organs are interconnected through bidirectional neural pathways, enabling dynamic regulation and maintaining homeostasis. This interconnectedness highlights the ANS's central role in physiological and psychological well-being, as most symptoms and ailments are both physical and mental.

Chronic defensiveness disrupts these homeostatic processes, leading to inflammation and reduced vagal tone. Conditions such as irritable bowel syndrome, fibromyalgia, heart disease, diabetes, and depression can be linked to these disruptions.

To improve health, regulating the stressed nervous system through co-regulation and therapeutic approaches that enhance homeostasis is helpful. With appropriate interventions, the nervous system can support the body's natural healing processes, promote overall health, and foster hope and resilience.

Glossary

afferent nerve pathways: Afferent nerves are sensory fibers that send information from the visceral organs and tissues to the brain. Approximately 80 to 90 percent of the signals sent via the vagus nerve are afferent.

ANS: An abbreviation for *autonomic nervous system*.

auditory hypersensitivities: Heightened sensitivity or responses to sounds that are experienced as pain or discomfort, while not bothersome to most.

autonomic nervous system (ANS): A division of the peripheral nervous system that regulates involuntary bodily functions such as heart rate, respiratory rate, blood pressure, pupillary response, digestion, urination, and sexual function. The ANS comprises three branches—sympathetic, parasympathetic, and enteric—that work together to maintain homeostasis and support health, growth, and restoration. Polyvagal Theory emphasizes the sympathetic and parasympathetic components.

autonomic state: Also known as physiological state. Refers to the current condition of the body's involuntary functions. According to Polyvagal Theory (PVT), there are three primary states: ventral vagal, sympathetic, and dorsal vagal. These states respectively support social connection, activation for fight/flight responses, or immobilized defensive behaviors. PVT assumes an "expanded" autonomic nervous system that appreciates the integration of autonomic pathways with other bodily physiological processes including endocrine, immune, and neuropeptide processes. Thus, the terms *autonomic state* and *physiological state* are used interchangeably in this book.

autonomic tendency: The natural inclination or predisposition to reflexively shift to a specific autonomic state in response to challenges, including danger cues. Some individuals tend to move to a sympathetic or dorsal vagal state, while others may exhibit a hybrid defensive state, such as the cyclic defense loop.

brainstem: A vital part of the brain and a key intersection between the brain and bodily organs involved in essential survival functions such as breathing, heart rate, blood pressure, respiration, and swallowing. Relevant to Safe and Sound Protocol, within the brainstem, the ventral vagal complex integrates both afferent (sensory/feeling) signals from the body and efferent (motor/behavior) signals from higher brain regions to coordinate ventral vagal output and corresponding autonomic, social, and emotional responses.

complex trauma: A condition resulting from exposure to multiple traumatic events over time, typically beginning in childhood. This exposure can disrupt the normal development of the brain and nervous system, impacting emotional regulation, relationships, and overall functioning.

co-regulation: The harmonious relationship between individuals that enables the mutual regulation of autonomic states. Through the social engagement system, one person's nervous system can influence another's, promoting both emotional and physiological well-being.

cranial nerves (CNs): A bundle of nerve fibers that transmits electrical impulses. There are 12 pairs of CNs originating from the brain and extending into various parts of the body. These nerves support a wide range of functions, including sensory perception (such as vision, hearing, taste, and smell), movement of the head and neck muscles, and autonomic functions like regulating heart rate, breathing, and digestion.

Dan Siegel's Hand Model of the Brain: A simplified metaphor for describing brain structure. In this model, the palm represents the brainstem, essential for basic bodily functions. The thumb—folded into the palm—symbolizes the limbic system, which regulates emotions and memory. The fingers, folded over the thumb, depict the cerebral cortex responsible for higher cognition and complex thought processes. When calm, the fingers rest on the thumb allowing clear thinking and sound decision-making. However, under stress, the fingers lift ("flipping our lid"), illustrating a disconnect between rational thought and emotions.

developmental trauma: Developmental trauma refers to adverse experiences during critical periods of childhood development that disrupt healthy growth and have long-term effects on an individual's physical and emotional well-being. Unlike a single traumatic event, developmental trauma involves pervasive exposure to stressful or harmful conditions during the formative years of a person's life. It can dysregulate the autonomic nervous system, affect attachment, impair cognition, and increase vulnerability to stress and trauma throughout the lifespan. With appropriate therapeutic interventions, it is possible to heal from developmental trauma.

diaphragm: A dome-shaped muscle that spans from the bottom of the rib cage, separating the chest cavity from the abdominal cavity. It plays a crucial role in breathing: when you inhale, the diaphragm contracts and moves downward, allowing the lungs to fill with air. During exhalation, it relaxes and moves upward, helping to expel air from the lungs.

dissociation: A phenomenon during which a person experiences a disconnection from their experiences, thoughts, feelings, or sense of identity. Often a coping mechanism in response to trauma, it can create a buffer from painful experiences. Dissociation exists on a continuum, ranging from mild detachment, such as daydreaming, to severe interruption in conscious experience. Through the lens of Polyvagal Theory, dissociation is an adaptive response to a prolonged neuroception of life threat.

dorsal vagal state: An autonomic state supporting immobilized defensive behaviors such as shutdown due to a neuroception of life threat. However, when integrated with the social engagement system it contributes to an immobilization state without fear that is highlighted in shared moments of intimacy.

dysregulation: Difficulty maintaining homeostasis in the autonomic nervous system, resulting in imbalances in both emotional and physiological responses. A dysregulated nervous system remains in a persistent state of threat leading to manifestations such as mood swings, impulsivity, anxiety, social withdrawal, and hypervigilance and physical symptoms like chronic pain, gastrointestinal problems, fatigue, and other related effects.

efferent nerve pathways: Neural pathways also known as motor fibers that transmit signals from the brain to tissues and organs. They control skeletal motor functions and regulate visceral organ activities. Approximately 10 to 20 percent of the signals carried by the vagus nerve are efferent.

heart rate variability (HRV): Heart rate variability is a measure of the variation in the time intervals between each heartbeat. It reflects the neural and nonneural influences on the sinoatrial node, the heart's pacemaker. Higher HRV suggests greater neural regulation of the heart, indicating that the autonomic nervous system is more adept at managing stress and maintaining health. Conversely, lower HRV often indicates a reduced neural regulation, which may signal stress or health challenges.

hertz (Hz): A unit measuring the number of sound wave cycles per second. Humans with excellent hearing typically hear sounds from 20 Hz to 20,000 Hz with lower frequencies perceived as bass and higher frequencies as treble.

implicit memory: Long-term memories acquired unconsciously, often without awareness and sometimes pre-verbally. These memories can influence thoughts and behaviors at a later time.

insula: A region of the brain in the cerebral cortex that integrates information from the body and facilitates communication among different brain regions. It plays a crucial role in interoception, receiving signals from the body and organs and integrating this information with emotional and cognitive processes.

interoception: The process of being aware of and sensing one's internal bodily sensations and condition. Interoception allows for conscious awareness of the body's internal state and plays a role in perceiving safety or threat through neuroception.

middle ear muscles: Two small muscles—the tensor tympani and the stapedius—located in the middle ear that play an important role in auditory processing. Influenced by the facial and trigeminal nerves (two of the five cranial nerves associated with the ventral vagal complex), these muscles control the tension of the eardrum by tightening to dampen background noise to enhance the perception of speech or relaxing to prioritize low and high frequencies associated with threats. The coordination of the activity of these muscles is often influenced by autonomic state. Safe and Sound Protocol was engineered to recruit the neural regulation of the middle ear muscles.

myelinated vs. unmyelinated pathways: Two types of nerve fibers in the nervous system differentiated by the presence or absence of a protective fatty coating of neuronal connections called myelin. Myelinated pathways are covered with myelin, allowing for faster transmission of nerve signals. The ventral vagus nerve is predominantly myelinated, while the dorsal vagus is primarily composed of unmyelinated fibers.

neural exercise: A practice or approach designed to stimulate change and improve brain and nervous system function.

neural feedback loops: Bidirectional circuits of neurons that allow the nervous system to communicate and regulate mental and physical responses to internal and external stimuli.

neural pathways: Bundles of nerve fibers that establish connections among neurons within and between various regions of the nervous system. These routes of connection form complex networks that enable sensory perception, motor control, cognitive functions, and the regulation of bodily processes.

neural regulation: The set of mechanisms and processes by which the nervous system controls and coordinates physical and cognitive functions in response to internal and external stimuli. Fundamental to many aspects of functioning, it includes integrating sensory information, processing signals, and activating appropriate responses to maintain homeostasis and adapt to changing conditions.

neuroception: The neural evaluation of safety and threat that reflexively triggers shifts in autonomic state without requiring conscious awareness. Not to be confused with perception and interoception, which both require awareness.

neuromodulator: A substance or input that modulates or influences the activity of the nervous system. A neuromodulator acts broadly to regulate the overall activity of neural circuits. For example, electrical stimulation of the vagus as well as social engagement and co-regulation are neuromodulators of autonomic state.

nucleus ambiguus: A brainstem region located within the ventral vagal complex from which the myelinated ventral vagus nerve originates.

perseverative thinking: Repetitive or prolonged thought patterns that involve repeatedly revisiting or dwelling on events, often without resolution. Perseverative thinking can include rumination, where individuals get stuck replaying past events or problems, leading to impaired concentration and increased anxiety and affecting overall well-being.

physiological state: See autonomic state.

Polyvagal Theory (PVT): A theory that explains how the autonomic nervous system regulates our physiological state and affects our behavior. Often referred to as the science of safety, PVT posits that our physiological state forms the foundation for our sensations, thoughts, emotions, and behaviors.

prosody: The rhythm, intonation, and variations in pitch, volume, and tempo in speech that convey meaning beyond the words spoken. Prosody communicates emotions, emphasis, and nuances in speech, significantly influencing how listeners interpret spoken language.

In general, prosody tends to be used to describe the positive affect embedded in speech.

PVT: An abbreviation for *Polyvagal Theory*.

regulation: In the context of the autonomic nervous system, regulation refers to the system's ability to maintain balance (homeostasis) and flexibility (resilience) in various mental and physical functions. Regulating one's autonomic state involves balancing the influences of sympathetic and parasympathetic states to sustain optimal physiological and emotional equilibrium, as well as adaptability.

retained primitive reflexes: Primitive reflexes are involuntary, automatic movements present at birth that are critical for a baby's development. When these reflexes persist beyond the developmental period, they are considered "retained" and can indicate developmental delays or neurodevelopmental issues.

Safe and Sound Protocol (SSP): A noninvasive therapy based on Polyvagal Theory, SSP involves listening to music that has been filtered to prioritize the frequencies of human speech. This auditory input enables the nervous system to be receptive to cues of safety and to downregulate defensiveness.

self-regulation: An individual's ability to manage their thoughts, emotions, and behaviors from a well-balanced autonomic nervous system. Self-regulation develops through co-regulation and can be strengthened by ongoing reciprocal social interactions with others. Self-regulation practices refer to activities that enhance the capacity for self-regulation when co-regulation is not possible.

shock trauma: A severe physical or psychological injury from a sudden, overwhelming event such as a severe accident, natural disaster, or violent assault. It can manifest as extreme physical and psychological pain, often accompanied by shock.

social engagement system (SES): A neural network involving five cranial nerves that enables individuals to detect and respond to social cues, thereby fostering positive social interactions. Activation of the SES occurs through ventral vagal outflow, facilitating pro-social signals such as facial expressions, vocalizations, listening acuity, head tilting, and regulation of the heart and lungs. This activation supports social connection by promoting engagement.

SSP: An abbreviation for *Safe and Sound Protocol*.

sympathetic state: An autonomic state supporting mobilized defensive behaviors, such as fight or flight, due to a neuroception of threat or danger.

vagal brake: A metaphor describing the capacity of the vagus nerve to slow heart rate when safety is perceived through neuroception. Physiologically, this is achieved through the release of acetylcholine. The metaphor extends to "releasing the vagal brake" to allow for a higher heart rate, increasing physiological activation to meet threats or engage in activities such as exercise, mental effort, and even simple movements. Vagal efficiency quantifies the effectiveness of the vagal brake.

vagal efficiency (VE): A specific measure of the robustness of the vagal brake quantified by the relationship between cardiac vagal tone (measured by respiratory sinus arrhythmia) and heart rate. Higher VE is associated with better access to the social engagement system. It also indicates more efficient regulation of heart rate, reflecting one's ability to respond effectively to stressors and maintain homeostasis. Lower VE seems to be an index of a dysregulated autonomic nervous.

vagal tone: The activity of the vagus nerve measured through the amplitude of respiratory sinus arrhythmia, a component of heart rate variability characterized by the rhythmic increases and decreases in heart rate within the frequency band of spontaneous breathing. It reflects the influence of the vagus nerve on heart rate regulation and is enhanced by experiences that support social and emotional engagement.

vagus nerve: The 10th cranial nerve and the longest and most complex of the 12 cranial nerves. Extending from the brainstem through the neck and into the abdomen, it plays a fundamental role in the autonomic nervous system by regulating various involuntary bodily functions. Through its afferent (sensory) and efferent (motor) pathways, the vagus nerve helps maintain psychological and physiological homeostasis.

ventral vagal state: An autonomic state dependent on the ventral vagal complex that supports social engagement behaviors like cooperation and connection. A neuroception of safety automatically moves the individual into a ventral vagal state.

viscera: Our internal organs such as the heart, lungs, digestive organs (stomach, intestines, etc.), liver, kidneys, and other vital organs.

How the Safe and Sound Protocol Came to Be

An Academic Love Letter from Dr. Porges

How the Safe and Sound Protocol (SSP) Came to Be: An Academic Love Letter from Dr. Porges

For more than 50 years, my research has focused on understanding how our physiological state influences our responses to all aspects of the world both inside and outside of the boundaries of our body. This broad realm of experience is dependent on our nervous system, which is continually assessing, interpreting, and responding to sensory information. This system involves the brain and all the nerves in the body that are either directly or indirectly communicating with the brain. Understanding how the nervous system coordinates these complex processes requires a thoughtful scientific strategy, which can be summarized in the following four principles.

How Physiological State Influences Our Responses to Everything

1. Sensory pathways drive development and refinement of motor pathways

This principle is confirmed through studies of development and phylogeny. Challenges to the nervous system conveyed through sensory pathways stimulate neuroregulation, neurogenesis, and neuroplasticity. In fact, neurostimulation is an emerging scientific discipline. Stimulation of sensory pathways of the vagus highlights the mechanisms through which vagal nerve stimulation works to optimize brain function, reduce inflammation and seizures, and optimize performance. Similarly, the Safe and Sound Protocol (SSP)–is a sensory driven intervention designed to enhance the central regulation of the social engagement system.

2. The brain evolved and developed from brainstem to cortex following a bottom up trajectory

Comparative neuroanatomy informs us the brainstems of virtually all vertebrates share common features and appear very similar. Through evolution, the higher brain structures emerged and evolved. For example, mammals can be distinguished from their reptilian ancestors by the development and expansion of the cortex. As a neurobiological principle, the evolutionary sequence estimate via comparative neuroanatomy is replicated in embryology as the brain develops in utero.

3. Newer brain structures functionally inhibit older ones forming a phylogenetically/ontogenetically determined hierarchy

The brain in mammals is the product of an evolutionary process through newer structures actively inhibiting and repurposing older structures. This point was clearly described by Damasio in his accessible book, *Descartes' Error*[1]. In the book, he describes Phineas Gage's "disinhibited" behavior following a head injury in which part of his prefrontal cortex was destroyed. This process of disinhibition has been a foundational concept in neurology and was described as "dissolution" or evolution in reverse by John Hughlings Jackson (1884)[2].

4. In response to illness and survival challenges, the nervous system functionally follows a strategy of dissolution or evolution in reverse

Polyvagal Theory (PVT) generalizes the Jacksonian concept of dissolution to the phylogenetic stages of the vertebrate autonomic nervous system. This provides an explanation of the neural mechanisms and autonomic state underlying the vast symptoms associated with functional medical disorders, disorders with symptom clusters that mimic pathophysiological disorders but cannot be confirmed by traditional medical assessments of end organ damage. Dissolution is the primary mechanism through which trauma and chronic stress disrupt health and repurpose the autonomic nervous system from supporting the homeostatic functions of health, growth, restoration, and sociality to supporting defense and survival.

In understanding the where and how SSP emerged, it is helpful to step back in time and share some of my scientific benchmarks as PVT evolved and expanded. These were experiences of posing questions and generating hypothetical solutions that were guided by PVT. As you travel the timeline with me, you will intuitively grasp how the theory led to an understanding of how the autonomic nervous system was intimately intertwined with human experiences. But moreover, you will intuitively move from an understanding of the physiology underlying mental and physical health challenges to hypothetical strategies to optimize outcomes by retuning the autonomic nervous system. PVT guided me toward the SSP as a gentle strategy that would coax the autonomic nervous system back to competence in optimizing our health and well-being. Below is an abbreviated timeline highlighting the introduction of features of PVT and leading to the SSP.

Timeline highlighting the introduction of features of PVT and leading to the SSP

- 1992: Paper published in *Pediatrics*[3] on the use of respiratory sinus arrhythmia in evaluating medical risk in preterm newborns
- 1994: Presidential address to the Society for Psychophysiological Research introducing Polyvagal Theory[4]
- 1995: Presidential address published in the journal *Psychophysiology* in an article entitled "Orienting in a Defensive World: Mammalian Modifications of Our Evolutionary Heritage. A Polyvagal Theory"[5]
- 1996: Introduction of the vagal brake[6]
- 1996: Introduced of the four-level model of regulation[7]
- 1998: Introduction of the social engagement system[8]
- 1998–2015: Development of the Listening Project Protocol (now SSP)
- 2003–2004: Introduction of neuroception[9]
- 2013 and 2014: Foundational studies documenting the effects of the Listening Project Protocol (now SSP) in children with auditory hypersensitivities and autism spectrum disorder[10, 11]
- 2017: Launch of the SSP via Integrated Listening Systems (iLs)
- 2018: Patent awarded for technology in the SSP[12]
- 2020: Introduction of vagal efficiency[13]

Understanding and Measuring Cardiac Vagal Tone: A Key Event Leading to PVT

Embedded in the above timeline is the critical event that led to the Polyvagal Theory. By 1992, my research was focusing on the applications of the technologies that I had developed to extract a valid and reliable index of cardiac vagal tone from the beat-to-beat heart rate pattern. This work led to a patent (US patent #US4510944A) and the establishment of a small company, Delta-Biometrics, that manufactured and marketed a vagal tone monitor (VTM) that integrated my patented technology to provide real-time analyses of respiratory sinus arrhythmia (RSA) as an index of vagal tone. The company also produced a software product that enabled other researchers to use our analytic procedures to quantify RSA.

The VTM used the same computer processor as the original IBM PC. The VTM did not have any moving parts. The front panel displayed the dynamically changing heart rate and amplitude of RSA. It required an ECG analog input and provided serial and parallel output ports to print the data in sequential selectable 10- or 30-second epochs. It even provided an automatic data editor that estimated values when the ECG signal was disrupted.

With the VTM and the offline analyses easily available to colleagues, my laboratory trained several hundred scientists to quantify RSA and to use our technology in their research. Finding business a distracter from research, I closed Delta-Biometrics in 2000, after selling approximately 100 VTMs to researchers. According to Google Scholar, the software and VTM have been cited more than 500 times in peer-reviewed papers.

The Vicissitudes of Research Funding

By 1992, I had assumed that my research trajectory, enhanced by the sensitive and available technology to quantify vagal tone that could easily be shared with colleagues, would be focused on clinical applications. This assumption led me to ask questions and to conduct research on the autonomic features of various clinical populations. I envisioned a pragmatic program of research that would be well-funded by the National Institute of Mental Health, as scientists were now exploring the role of autonomic regulation in mental health, medical diseases (e.g., diabetes, cancer), developmental disabilities (e.g., autism, Down syndrome), social behavior, and cognitive functions.

The Pivotal Letter

Following the publication of the 1992 *Pediatrics* paper, I received a letter from a neonatologist that would change my research trajectory and lead me to develop the Polyvagal Theory. This letter reminded me that neonatologists as well as obstetricians have been trained to interpret clinical bradycardia, the massive slowing of heart rate that could be lethal, as being a vagal phenomenon. In my work with high-risk neonates, the bradycardia described by the neonatologist seemed to only occur when RSA was low. This was later confirmed (see Reed et al., 1999).

Thus, I hypothesized in the 1992 paper that RSA was an index of more optimal autonomic regulation and positive outcomes. The neonatologist ended his letter by assuming that there was a common vagal source leading to both RSA and bradycardia and perhaps too much of a good thing was bad.

His comment was set within a background of how the neural regulation of the autonomic nervous system was currently being taught in medical schools. Basically, the broad view was that vagal activity, often generalized to be inclusive of all parasympathetic activity, was assumed to serve homeostatic functions when within a functional band of activation, suggesting that too low or too high might result in pathophysiology. However, based on my own research experience, I did not agree with his suggestion of an inverted U-shaped relation between vagal tone and health.

Within this view, vagal activation up to a specific level, reflected in RSA, would index optimal function, while increasing beyond that point would produce bradycardia and health risk. However, his suggestion was consistent with the Yerkes-Dodson law, a dominant view in psychology proposing an inverted U-shaped function between arousal and performance where, once an optimal level of arousal was exceeded, performance declined. In the law, arousal is conceptualized as either sympathetic or cortical activation.

Note that this is also consistent with Dr. Dan Siegel's well-accepted "window of tolerance" within mental health treatment models.[14] However, the window of tolerance model is more consistent with the Polyvagal Theory by acknowledging that the tails of the inverted U-shaped function are mediated by different mechanisms.

The neonatologist's letter triggered my curiosity, and I was perplexed by the possibility of a "vagal paradox". After carrying the letter in my briefcase for a few months, I drafted the paradox into the two sentences below.

1. Bradycardia is a potentially lethal risk index mediated by the vagus.
2. RSA is a protective factor index mediated by the vagus.

This contradiction in interpretation of vagal mechanisms formed the basis of the vagal paradox by posing the question: How could the vagus be both protective, when it was expressed as RSA, and life-threatening, when it was expressed as bradycardia and apnea? By formulating the paradox, it became clear to me that the vagus was involved in sending contradictory signals to the heart. Now I had to find an explanation of how the vagus could index both health and risk; how it could both protect and injure the heart. This led me into a deep literature review of all things vagal. Identifying the vagal mechanisms underlying the paradox evolved into the Polyvagal Theory.

A Polyvagal Solution

In 1993 when I started on this quest, I was a faculty member at the University of Maryland. At that time, I also held an appointment as an Adjunct Scientist in the Laboratory of Comparative Ethology at the National Institute of Child Health and Human Development within the National Institutes of Health (NIH). The laboratory chief, Stephen Suomi, was a good friend and colleague in the area of developmental psychobiology. Within his laboratory, I collaborated with another friend and colleague, Michael Lamb, chief of the section on Social and Emotional Development.

My position at NIH provided me with access to their library and research librarians. I also had the privilege of borrowing books from the National Library of Medicine. Both resources were walking distance from my home and provided me with access to the scientific literature documenting what was currently known about the vagus nerve. This exploratory journey occurred prior to the internet with the search tools of Google Scholar and PubMed. This was still a time of inquiry dependent on physical journals and books, and the NIH librarians were helpful in printing out abstracts of journal papers from dedicated searches.

After spending weeks wandering into the stacks of the NIH library, I ended up exploring books and journals in comparative anatomy. Comparative anatomy is an intriguing discipline that identifies similarities and differences in anatomical structures across vertebrate species. Comparative disciplines are helpful in generating hypotheses regarding evolution.

From this comparative perspective, vagal pathways followed an evolutionary sequence. Suddenly, the paradox was solved. In reptiles and more primitive vertebrates, the vagus reliably produces bradycardia and is frequently involved in defensive strategies of immobilization including death feigning. While in mammals, the ventral vagus was linked to calmness and sociality. For the preterm newborn, the ventral vagus is not fully functioning, and the infant enters the world with an autonomic nervous system (ANS) that has many attributes of a reptile. Thus, the clinical bradycardia was functionally a defense reaction to conserve metabolic resources, which would be adaptive in the earlier- evolved vertebrates who had small brains without limited need for oxygenated blood.

Hypotheses driven by PVT are related to the documentation that the mammalian ANS has a built-in hierarchy of autonomic reactivity based on phylogeny that is mirrored in embryological development. In other words, the hierarchical nature of the ANS results from how it developed evolutionarily, and that same development can be seen in the way a fetus's ANS develops and grows in the womb—with older circuits developing first.

This fact became a core principle upon which PVT-informed hypotheses could be tested. This emphasis on hierarchy is focused on ANS reactivity and does not preclude the optimal homeostatic states that involve a synergism and functional balance between parasympathetic and sympathetic influences (i.e., hybrid states). For example, based on the state of the ventral vagus and the social engagement system, we can determine if children are playing or fighting. The distinction becomes clear when we look at their faces and listen to their voices. Similarly, the social engagement system can calm an infant sufficiently to move into a restful dorsal vagal state that would support health, growth, and restoration. Thus, depending on the state of the ventral vagus, autonomic regulation may function either hierarchically, synergistically, or antagonistically.

The "Polyvagal" solution to the vagal paradox emphasizes that:

1. Not all vagal pathways support social communication, downregulate stress, and enhance resilience.
2. There are vagal pathways that can be recruited for defense and are potentially lethal.
3. The neural circuits regulating the autonomic nervous system function hierarchically in which evolutionarily newer circuits inhibit older ones.
4. Development of the neural pathways regulating the autonomic nervous system parallel phylogeny with evolutionarily older circuits developing first.

The Discovery of the Social Engagement System

Although the relationship between the ventral vagus and muscles of the face and head was described in the introduction of the Polyvagal Theory (see Footnote 5), it took a few years to gain a better grasp of how these neural pathways were related to PVT. Serendipitously, I was invited to participate in an innovative workshop entitled "Is there a neurobiology of love?" The workshop invited scientists across several disciplines to discuss how biological systems were involved in social relationships. The result of the meeting was a well-cited special issue of the journal *Psychoneuroendocrinology* (see Footnote 8).

The meeting was organized by Dr. Sue Carter. Sue is the scientist who identified the important role of oxytocin in social behavior. She is noted for her observations of the prairie vole, a rodent species that create lifelong bonds with their mated partners. Sue is also my wife and has been instrumental in shifting my research trajectory toward sociality, co-regulation, and trust. We were married in 1970 and have independent, although parallel, career trajectories. In fact, it took more than 20 years to realize that we were studying overlapping phenomena from complementary perspectives.

Sue focused on the neuropeptides of oxytocin and vasopressin, while I focused on autonomic regulation emphasizing the expansive role of vagal circuits. I frequently mention in my talks that although we were married, it took about 20 years until we were reacquainted in the brainstem. There is factual substance in that statement, since the brainstem nuclei related to the vagus have an abundance of receptors sensitive to both oxytocin and vasopressin. We soon discovered that there was synergism not only in our personal lives but also in our research. And, similar to all good relationships, we were able to respectfully explore similar phenomena from two perspectives.

I felt challenged by the invitation and decided to explore how PVT would approach the proposed question. As I explored the circuits that were identified in the initial PVT paper, I realized an interesting and compelling circuit related to sociality and nursing emerged with the ventral vagus. Functionally, evolutionary processes resulted in a system that linked vagal pathways that could slow heart rate and calm autonomic state with the structures that mammals use to signal and detect cues of safety and trust.

Early in development, this system is involved in nursing and requires the coordination of sucking, swallowing, breathing, and vocalizing. This coordination requires vagal pathways, including the vagal pathways regulating the laryngeal and pharyngeal muscles that produce the intonations of vocalizations. This mammalian innovation of parallel vagal pathways influencing heart rate and intonation provided the mechanism to literally broadcast autonomic state to a conspecific, another of the same species.

Of course, we recognize this feature in support of infants and even our pets, who broadcast their needs for food or feelings of distress in the intonation of their vocalizations. A deeper dive into this circuit identified an area of the brainstem that could be labeled the ventral vagal complex, since it contains brainstem nuclei linking the regulation of the ventral vagus with the striated (skeletal) muscles of the face and head. In preparing for the conference and the subsequent journal article, I realized that this neural circuit not only formed the basis of nursing but provided a circuit involved in establishing social engagement, connection, and trust. Moreover, this circuit is involved during the process of listening and influences our ability to process and interpret the acoustic world around us.

Within Polyvagal Theory, the evolutionary trajectory of the vagus has led to a conceptualization of an emergent and uniquely mammalian social engagement system in which a modified branch of the vagus is integral. Neuroanatomically, this system is dependent on a brainstem area known as the ventral vagal complex. This area not only regulates the mammalian ventral cardio-inhibitory vagal pathway but also involves pathways within other cranial nerves controlling the striated muscles of the face and head. This does not preclude other structures being involved in mammalian social engagement behaviors or homologous structures in other vertebrates that do not share our phylogenetic history exhibiting social behaviors.

The relationship between mothers and their nursing offspring illustrates the social engagement system in action. To survive, mammalian offspring must initially nurse as the primary mode of ingesting food. To nurse, the infant must suck, a process dependent on a brainstem circuit involving the ventral vagal complex. Survival is dependent on the infant's nervous system efficiently and effectively coordinating suck-swallow-breathe-vocalize behaviors with vagal regulation of the heart through the ventral vagal pathways. Through maturation and socialization, this "ingestive" circuit provides the structural neural platform for sociality and co-regulation to act as major mediators optimizing homeostatic function leading to health, growth, and restoration (see Footnote 3).

For mammals, there is a dependency between reactions to contextual cues and the function of this circuit. Cues of threat may disrupt, while cues of safety may enhance function. The sensory branches of the facial and trigeminal nerves provide major input into the ventral vagal complex. Functionally, changes in the state of this circuit, through the process of dissolution, will either "disinhibit" phylogenetically older autonomic circuits to support defense (e.g., against a predator, disease, physical injury) or inform all aspects of the autonomic nervous system, including the enteric system (see Footnotes 13, 14), to optimize homeostatic function.

Mammals, unique from their ancestral reptiles, have detached middle ear bones, which distinguish them from reptiles in the fossil record. Detached middle ear bones expand the frequency band that mammals can hear and provide a "safe" frequency band in which they can socially communicate that will not be detected by reptiles.

Early Clues to Developing SSP

Serendipitously, my investigation of middle ear structures led to the development of the SSP. Middle ear bones (as a group of three, called ossicles) are small bones that separate from the jawbone during gestational development and form an ossicle chain that connects the eardrum to the inner ear. Small muscles regulated by branches of the trigeminal and facial nerves determine how sound is transmitted through the middle ear. These muscles also determine the loudness of specific sound frequencies transduced through middle ear structures (i.e., middle ear transfer function) by controlling the stiffness of the ossicle chain and the tightness of the eardrum.

When the ossicle chain is stiff, the eardrum is tighter and low-frequency sounds are dampened, but when the muscles relax, lower-frequency sounds pass into the inner ear. In all mammalian species, based on the physics of their middle ear structures, there is a *"frequency band of perceptual advantage"* that is available when the middle ear muscles contract and stiffen the ossicle chain (see Footnote 15). It is within this frequency band that social communication and acoustic signals of safety occur for mammals. This is possible because the low frequencies that, through evolution, had been associated with predators are dampened (see Footnote 16). In the reptile ancestors that preceded mammals, the middle ear bones were still fused to the jawbone. This means they could not hear higher-frequency sounds, resulting in mammals being able to communicate through vocalizations that reptiles cannot hear.

Interestingly, the coordination of the contraction and relaxation of these small muscles is frequently co-regulated with autonomic state and thus contract when there is strong ventral vagal tone to promote social communication and co-regulation. In contrast, when the autonomic nervous system shifts to a state of defense, the muscles relax to detect low-frequency predator sounds, which supports defense strategies relying on auditory cues. This parallel between autonomic state and defensiveness may explain why many children with problems in auditory processing and language delays may also have behavioral state regulation limitations.

Using the Middle Ear Muscles to Retune the ANS

The neurophysiological link between autonomic state and the middle ear muscles provided a portal to regulate autonomic state through acoustic stimulation, which is easily observable when a mother calms her infant using prosodic vocalization. Similarly, we can observe the potent calming influences when a pet is calmed by the voice of a human. We may think it is the magic of our words, while it is actually the intonation patterns communicating in the frequency band of perceptual advantage. Of course, the smaller the child or mammalian pet, the smaller their middle ear structures, and the higher their frequency band of perceptual advantage. Thus, the frequency band in which the infant or pet detects signals of safety requires the higher pitch that characterizes how adults apparently intuitively produce infant and pet-directed speech.

The mother-infant interaction provides a platform to explore the intuitive origins of the SSP. Effective mothers, caregivers, and teachers have intuitively used their social engagement system to broadcast vocal and facial signals of safety to their children, patients, and students. Recently, we published a study documenting the powerful relationship between quantifiable acoustic parameters of maternal voices while calming their infants following an experimental procedure that stressed the infant[15]. Following the stressful experience, the mother was instructed to engage and calm her infant. We investigated the vocal qualities of the mother's voice and the infant's distress and heart rate. Our analyses documented a strong relationship between the prosodic characteristics of the mother's voice and the infant's heart rate and distress behavior.

Analysis of the mother's voice provided a metric of vocal intonation conveying positive prosodic features. Confirming our hypothesis, mothers whose vocal intonations were more melodic were more effective in calming their infants. The mothers with the most prosodic voices reduced infant heart rate more than 10 beats per minute, while the least prosodic voice had no impact on the infant heart rate. Similarly, a measure of behavioral distress paralleled the changes in heart rate. The study confirmed a common belief in how to calm children and pets. Interestingly, this intuitive strategy seems to have been missed by teachers and health-care providers.

The Foundational Building Blocks of SSP

The above information serves as the foundational building blocks that were integrated into SSP. Below, these foundational principles derived from PVT can be outlined:

1. Pitch and especially the modulation of pitch are critical in signaling safety and calming the autonomic nervous system.
2. The frequency band of perceptual advantage is a functional product of the middle ear structure, which essentially dampens low-frequency sounds and enhances the sounds of social communication.
3. Listening both influences and is influenced by autonomic state.
4. Acoustic signals of safety broadcast the accessibility of another (e.g., a mother's soothing voice) via neuroception, which reflexively calms the autonomic nervous system of the listener.
5. The SSP is a neural exercise that progressively expands the capacity of the dysregulated autonomic nervous system to process the full frequency band of perceptual advantage.

6. The capacity to process the full range of the frequency band of perceptual advantage dampens the hypersensitivities to threat signals while enhancing the attributes of the ventral vagal complex—spontaneous social engagement, biobehavioral resilience, co-regulation, and optimizing homeostatic function.

The Early History of SSP

Between 1985 and 2001, when I was a faculty member at the University of Maryland, I was interested in the autonomic and behavioral regulation of children who were on the autism spectrum. To me, the behaviors expressed by these children seemed to be naturally emergent from an autonomic nervous system locked in a state of defensiveness. I still vividly recall my laboratory interactions with children diagnosed with autism spectrum disorders and their families. Paramount in these memories were their destabilized behavioral state, their tactile and auditory defensiveness, their selective eating, and their frequent noncontingent responses to caregivers' attempting to calm them.

At that time, I met and had frequent discussions with Dr. Stanley Greenspan. Stanley was a passionate child psychiatrist who had a model to optimize the social behavior of autistic children through reciprocal interactions. In general, his model invited the parent to follow the child's lead. In the model, the child's behaviors were being encouraged by the parents' accessibility and reciprocal interactive exchanges.

This strategy was challenging to the intervention community, which had assumed that behavior modification was the preferred mode of intervention. Behavior modification, officially known as Applied Behavioral Analysis, or ABA, was the accepted treatment model in special education and the treatment of children on the spectrum. However, Greenspan opposed the prevailing model and argued against enforcing a strict stimulus-response model. Greenspan formulated his model into a strategy that is known as Floortime. Although not necessarily stated by Greenspan, Floortime and ABA are both based on a learning model; ABA on an objective reinforcer (e.g., reinforcing with M&M's), while Floortime used a more ecologically valid reinforcer (e.g., the parent's engagement behavior).

As I was formulating PVT at that time, I was curious if deficits in interactive social behavior were dependent on autonomic state. Based on my research I had two working hypotheses. The first hypothesized a relationship between autonomic state and the development of contingencies. The second hypothesized that there were measurable neurophysiological contingencies within the autonomic nervous system that were a foundational substrate underlying observable contingent behavior.

The first hypothesis was consistent with my earlier research, which documented that autonomic state influenced the contingency of an infant's heart rate to reliably react to and even anticipate auditory and visual stimuli. For example, even during the newborn period, infants with greater ventral vagal influences to the heart responded with more reliable heart rate reactions to sensory stimuli and even developed anticipatory heart rate reactions when the stimuli were presented repeatedly at fixed intervals. Similarly, adults with greater ventral vagal influence were more likely to develop anticipatory heart rate responses when a signal preceded the required response in a reaction time task. This form of learning of a temporal contingency is known as temporal conditioning. My early research was suggesting that autonomic state mediated both autonomic reactivity and contingency learning.

The second hypothesis was consistent with my work in the 1980s during which I was developing new metrics to describe the coupling between breathing and heart rate. Specifically, I developed a metric, which I called "weighted coherence," that quantified how tightly coupled (i.e., contingent) changes in breathing were related to the periodic changes in heart occurring at the same frequency as breathing known as respiratory sinus arrhythmia (RSA). The amplitude of RSA has subsequently been used as the gold standard for estimating cardiac vagal tone.

Coherence is conceptually similar to correlation, but it is a "frequency" domain metric. Coherence evaluates the coupling between two time series (i.e., signals that are indexed by time). In my work, the time series data were the dynamically changing chest circumference (i.e., breathing) and the synchronous beat-to-beat changes in heart rate that approximated a respiratory pattern (i.e., RSA). When coherence approaches 1.0, breathing changes are directly mapped into the heart rate pattern. With high coherence, there is an observable phase locking during which changes in breathing are reliably related to changes in heart rate. Thus, the higher the coherence, the more contingent RSA was to breathing. Since breathing rate varies, weighted coherence provides a summary statistic of this form of contingency across the frequency band of spontaneous breathing. As I developed this metric, I modeled a hierarchy in which neural contingency formed the foundation of contingent social behavior. Thus, I hypothesized that poor autonomic regulation was foundational to noncontingent behaviors expressed by individuals on the spectrum. Based on this speculation, I hypothesized that signals of calming and safety would recruit the ventral vagal complex to promote sufficient accessibility to express contingent social behavior. As the Polyvagal Theory evolved, I began to understand the profound signal power of prosodic vocalizations in calming and started to use the mother's vocal calming of an infant and our vocal engagement of our mammalian pets as a model for a potential intervention.

Earlier I proposed a hierarchical model of self- and co-regulation to provide insights into optimizing intervention strategies for high-risk infants[16] . Since individuals on the autism spectrum frequently have difficulties in these same domains, the model is helpful in understanding my insights into developing the SSP as a portal of calming to enhance accessibility and social contingency. The model reflects maturational competencies in neural regulation that provide a substrate for the more complex co-regulatory social behaviors. The main point of the model is that higher behavioral functions, which are frequently intentional, are dependent on the functioning of the more survival-focused foundational systems embedded in the brainstem. To me, it was obvious that the autistic phenotype behaviorally embodied difficulties in state regulation as well as noncontingent social behavior, both being assumed to be intentional. I speculated that brainstem efficiency in regulating autonomic state might be a foundational portal into understanding some of the prominent features of autism. Moreover, since these features were functionally an adaptive reaction to signals of threat, I speculated that signals of safety might shift an autonomic state that supports defensiveness to an autonomic state that supports social engagement and contingent co-regulation. The SSP grew out of these insights and speculations. The levels are described in Table 1.

Level I is focused on the function of brainstem structures in optimizing physiological homeostasis through neural and neurochemical bidirectional communication between visceral organs and brainstem structures. The neural pathways involved in Level I are functional at birth in healthy full-term infants. An index of Level I can be derived from quantifying RSA, a periodic component of beat-to-beat heart rate variability that is synchronous with spontaneous breathing and a valid index of cardiac vagal tone via ventral vagal pathways[17].

Level II emphasizes connections between higher brain structures and the brainstem in regulating autonomic state. Success in Level II is achieved when the suck-breathe-vocalize circuit is integrated with the ventral vagal pathway[18]. This circuit enables nursing and soothing to occur and is dependent on the neural pathways that define the ventral vagal complex and support the social engagement system (see Footnote 8). Similarly, the weighted coherence and the more recent vagal efficiency metric tap into the coordination among brainstem nuclei communicating with the ventral vagal complex, the pathways that foster social communication and co-regulation. Level II provides the foundational neural platform for feelings of safety and access to the circuits that would enable a neuroception of safety.

Table 1 emphasizes the hierarchical nature of specific autonomic states and accessibility of behaviors that we cluster as self-regulation skills. The optimal function of each level is dependent on each of the preceding levels being adequately functioning.

Focusing on Levels I and II we see that optimal behavior is dependent on the neural regulation of the autonomic nervous system and the connectivity between cortical areas, allowing the accurate interpretation of cues of safety and threat, and the brainstem areas regulating the autonomic nervous system. The quantification of RSA provides a quantitative portal into Level I, while the weighted coherence and vagal efficiency metric would reflect Level II competency.

In an autonomic state that supports threat, even the foundational processes described in Levels I and II would be compromised. When these foundational levels are functional, the nervous system can support coordinated goal-directed behaviors (Level III) and contingent social interactions (Level IV). It was obvious, as I observed the diverse phenotype of autism, that there was a core feature of defensiveness that could be detected in behavior, facial expression, and intonations of vocalizations. I hypothesized that underlying these features was an autonomic state locked in defense. My response to this hypothesis was the SSP.

Table 1: Hierarchical model of self-regulation (Porges, 1996).

Level I: Neurophysiological processes characterized by bidirectional communication between the brainstem and peripheral organs to maintain physiological homeostasis.

Level II: Physiological processes reflecting the input of higher nervous system influences on the brainstem regulation of homeostasis. These processes are associated with modulating metabolic output and energy resources to support adaptive responses to environmental demands.

Level III: Measurable and often observable motor processes, including body movements and facial expressions. These processes can be evaluated in terms of quantity, quality, and appropriateness.

Level IV: Processes that reflect the coordination of motor behavior, emotional tone, and bodily state to successfully negotiate social interactions. Unlike those of Level III, these processes are contingent with prioritized cues and feedback from the external environment.

Creating and Researching the SSP

In the late 1990s, with PVT as a model, I started to deconstruct the features of autism and to work on an acoustic intervention. The intervention was initially called the Listening Project Protocol (LPP).

By the late 1990s, through my friendship and collaborations with Stanley Greenspan, I had spent hundreds of hours observing autistic children. I witnessed the defensiveness of these children's physiology and their hypersensitivities. I intuitively wanted to calm their nervous systems to enable them to feel more comfortable in their bodies. Based on a desire to reduce their sensory burden and to provide expanded moments during which they and their parents could feel connected with each other, I started to conceive of a stealth intervention, a way of calming that was totally different from the treatment models that emphasized behavioral modification techniques in the 1990s. As I watched these children, I would cringe as they were treated in a robotic deterministic manner using food (e.g., M&M's) to shape their behaviors. I saw the children as being locked in a state of threat. I wondered how their lives would be if they felt safe enough to literally give up their defenses and calm. I wondered if PVT would provide the insights to craft such an intervention. Thus, the SSP, or more accurately the LPP, was prototyped as a stealth intervention that communicated with the hardwired circuits that the prosodic vocalizations of a mother's lullaby intuitively recruited.

I envisioned a neural exercise in which the acoustic signal would be ported into the child's nervous system through a narrow frequency band that would be available even when in a defensive state. The intervention would progressively expand and contract the portal until the child experienced and welcomed the entire frequency band of perceptual advantage, that is, the frequencies through which social communication occurs. I theorized that as the acoustic frequency band expanded and contracted, not only would the dynamics of the middle ear structures be recruited to optimize the processing of these signals of safety, but the entire social engagement system would become available. I visualized the LPP as recruiting the powerful calming of the ventral vagus, enhancing the prosody of the child's voice, reducing auditory hypersensitivities, enhancing facial expressivity, and even impacting on ingestive behavior.

With a prototype created with an early version of Adobe Audition, I set up a laboratory at the University of Maryland to test children on the autism spectrum. The protocol was structured as a neural exercise with five one-hour sessions being delivered on five sequential days. Our research staff engaged the children and their parents to support the biobehavioral state of their child. Parents and staff would provide toys and food. In the initial pilot study, I had the idea that the social stimulation of peers would facilitate effectiveness, and four children simultaneously received the intervention. The computer-altered music was played on a CD player that had an output adapter connecting to headphones with long cords. This allowed the children to move around the room.

During the initial pilot study, we observed completely unexpected behaviors. Children began sharing and exhibiting reciprocal play behaviors. Perhaps my most poignant memory from these early reactions to the LPP involves a child who could not tolerate wearing a headset. To address this challenge, I constructed a special sound-attenuated cube using sound-dampening blankets attached to PVC pipes with Velcro fasteners. When this hypersensitive nonverbal child entered the cube and heard the computer-altered music, he clearly articulated one word: "Safe."

We received reports of children telling their parents they loved them for the first time. Fathers shared that, as their child's social engagement system became functional, they felt they truly had a son. These moments highlighted a profound shift as families became more connected to their children.

Our research documented that the features of the social engagement system (see Footnote 8) were consistently dampened in these children, irrespective of diagnosis severity, cognitive functioning level, or hypersensitivity profile. Through continued investigation, we began to document how this "stealth" intervention significantly reduced hypersensitivities, improved auditory processing, encouraged sharing behaviors, enhanced emotional regulation, and promoted spontaneous social engagement. These insights informed our approach, and our staff intuitively adopted a Polyvagal-informed perspective in their co-regulatory and supportive interactions with autistic children and their families.

In 2001, we relocated our laboratory from the University of Maryland to the University of Illinois College of Medicine's Department of Psychiatry. At Illinois, we established the Brain-Body Center, a relatively large research center dedicated to advancing our understanding of autism and related conditions. We collected additional data and dedicated significant time to analyzing and interpreting the findings we had gathered in Maryland. As a scientist, my training equipped me to structure research questions, test hypotheses, and propose explanations. However, the real challenge lay in translating these findings into practice. I was neither trained nor prepared to develop an accessible, scalable treatment model for therapists.

Fortunately, in 2015, I met Karen Onderko and Randall Redfield, the CEO of Integrated Listening Systems. Our interactions led to Integrated Listening Systems licensing the technology embedded in the LPP. The protocol was renamed the Safe and Sound Protocol and introduced to the broader clinical community in early 2017.

It is through the experiences and collaboration of early adopters that the SSP's understanding, protocols, and potential have evolved. Research is inherently a team effort, and these pioneering providers—and those practicing today—have played a critical role in refining its delivery. By tailoring the SSP to meet the needs of individual clients and incorporating their attuned presence and co-regulation into the process, they have deepened our understanding of its application. We have gained invaluable insights from their experiences and look forward to continuing to learn from their contributions.

Footnotes

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