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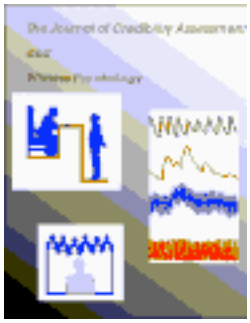


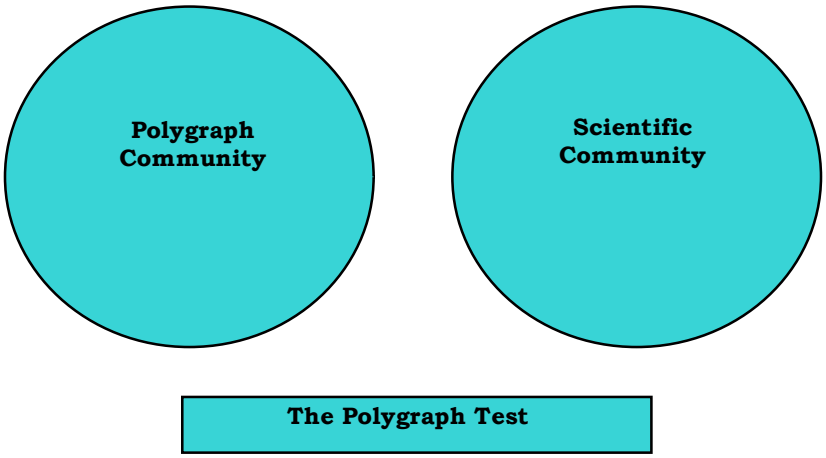
The Polygraph: One Machine, Two World Views

Stephen W. Porges, Ph.D.

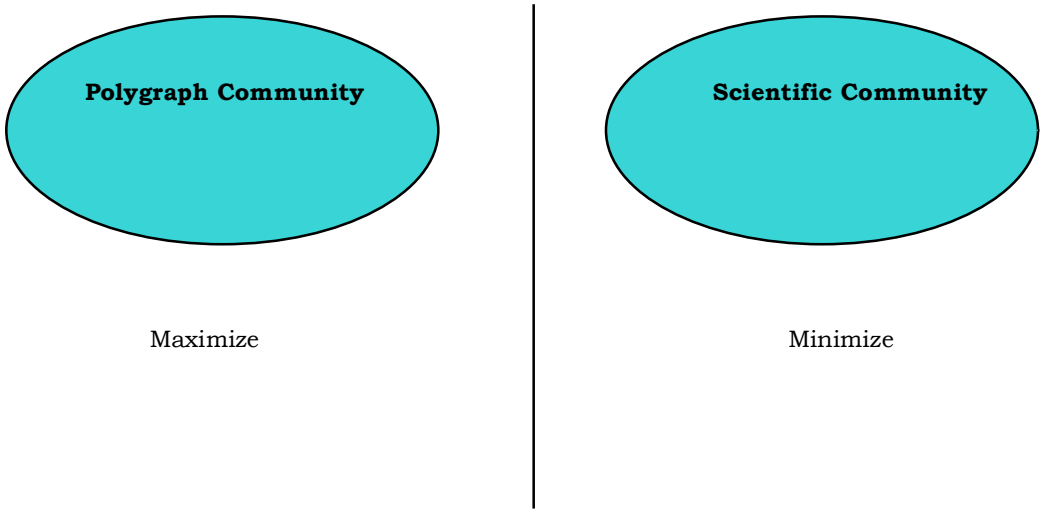
Brain-Body Center,
University of Illinois at Chicago, Chicago, Illinois

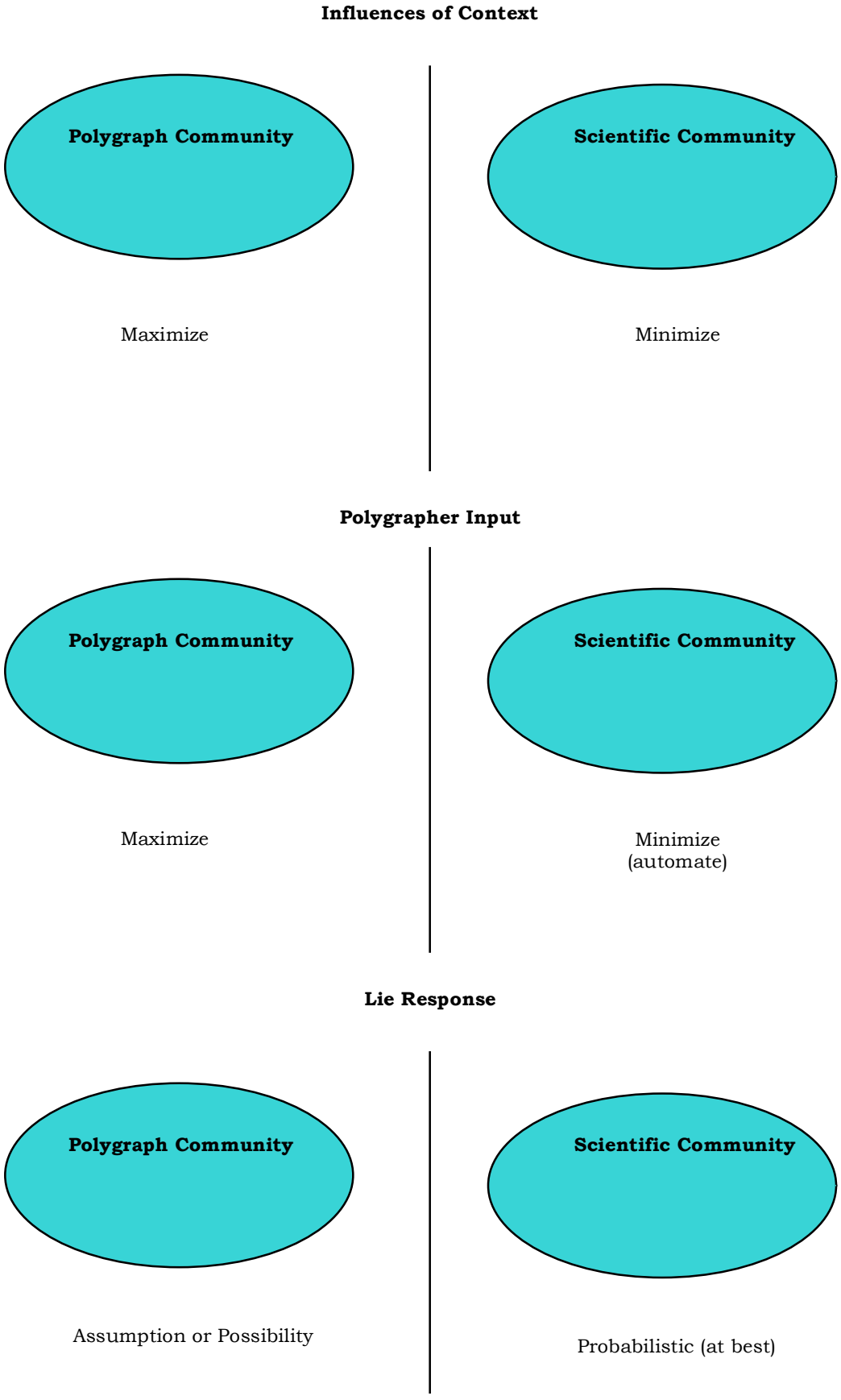
The Polygraph: One Machine, Two World Views

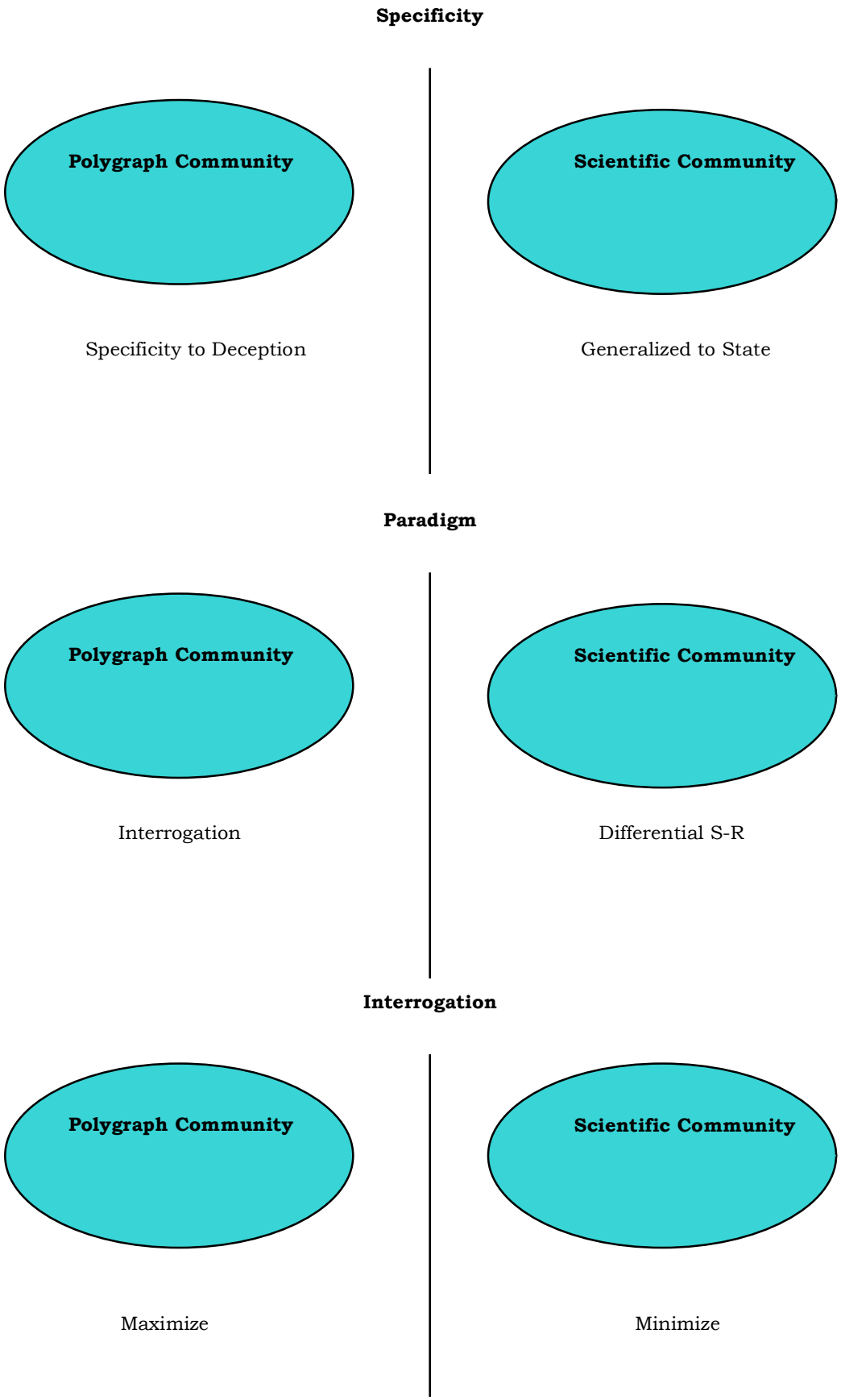
Allies or Adversaries



Interrogation




Influences of Context
Polygraph Community
Scientific Community
Maximize
Minimize
Polygrapher Input
Polygraph Community
Scientific Community
Maximize
Minimize
(automate)
Lie Response
Polygraph Community
Scientific Community
Assumption or Possibility
Probabilistic (at best)


Specificity
Polygraph Community
Scientific Community
Specificity to Deception
Generalized to State
Paradigm
Polygraph Community
Scientific Community
Interrogation
Differential S-R
Interrogation
Polygraph Community
Scientific Community
Maximize
Minimize

Evaluation Criteria

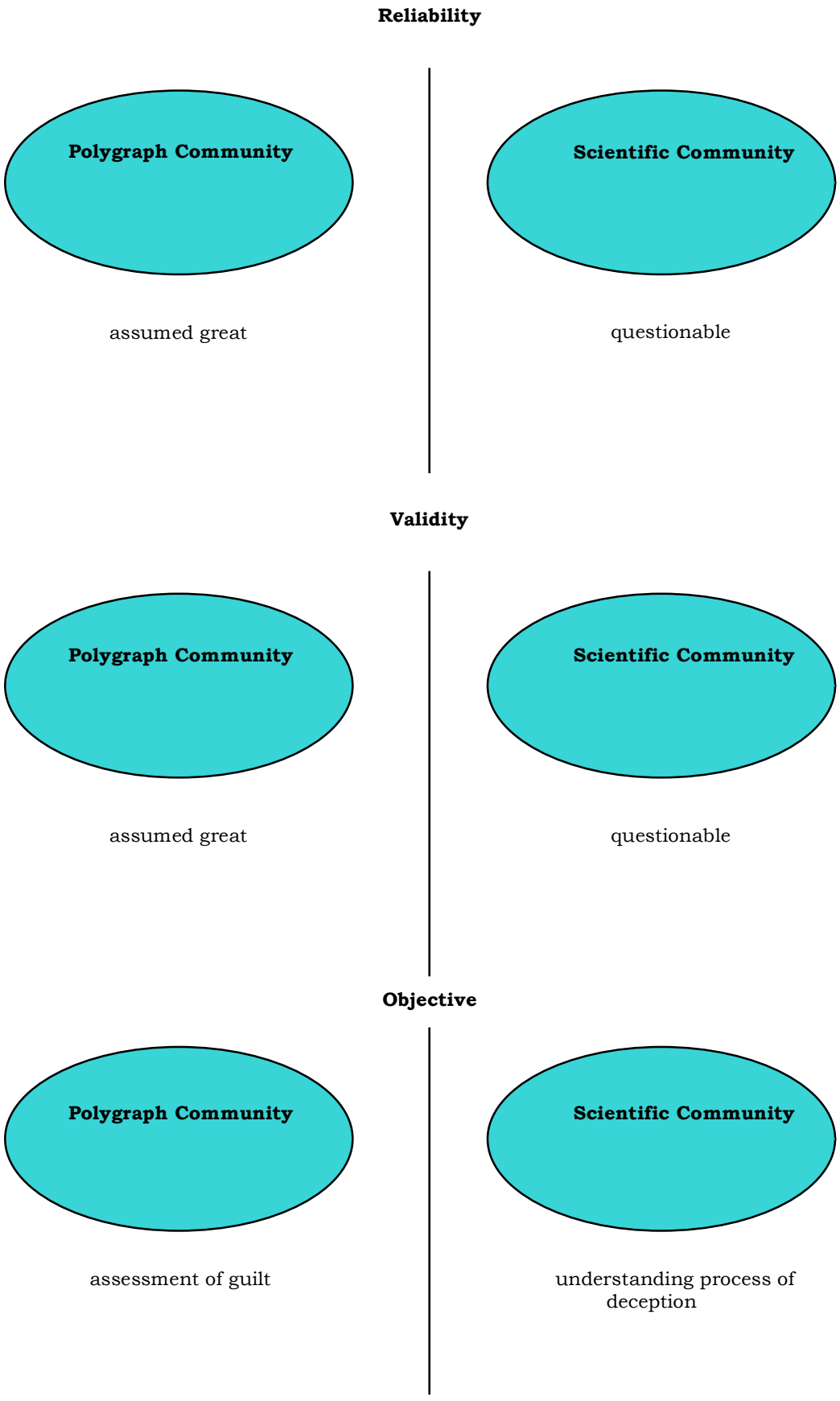
Polygraph Community	**Scientific Community**
Confession with chart Subjective	Chart Objective & Quantifiable (numerical/computer)

Expectation of Science

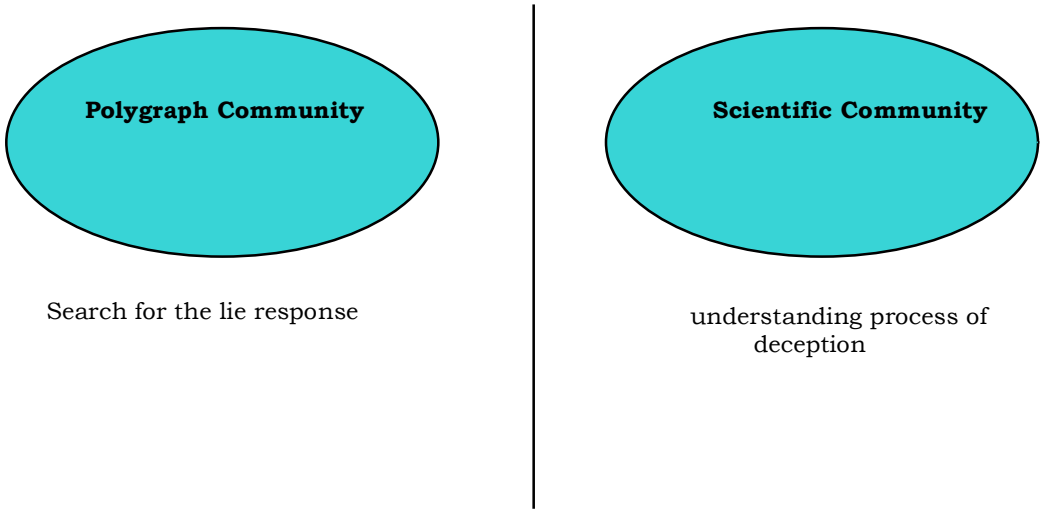
Polygraph Community	**Scientific Community**
a "lie" response	better methods of quantification better methods of data collection better models of explanation

Configuration of Polygraph

Polygraph Community	**Scientific Community**
works great	old technology - **limits specificity** - **imposes "blinders"** - **limits statistical inference**


Reliability
Polygraph Community
Scientific Community
assumed great
questionable
Validity
Polygraph Community
Scientific Community
assumed great
questionable
Objective
Polygraph Community
Scientific Community
assessment of guilt
understanding process of deception

Research Objectives



Conclusions

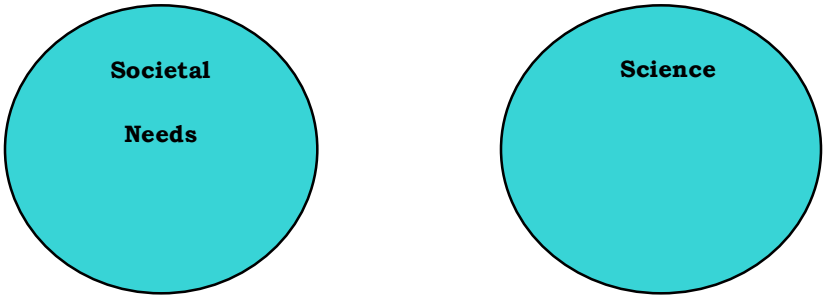
1. Better understanding of mutual objectives and competencies
2. New research agenda to provide appropriate tools for polygraphy
    a. The development of new paradigms
    b. Improvement of quantitative techniques

Emerging Technologies in Credibility Assessment

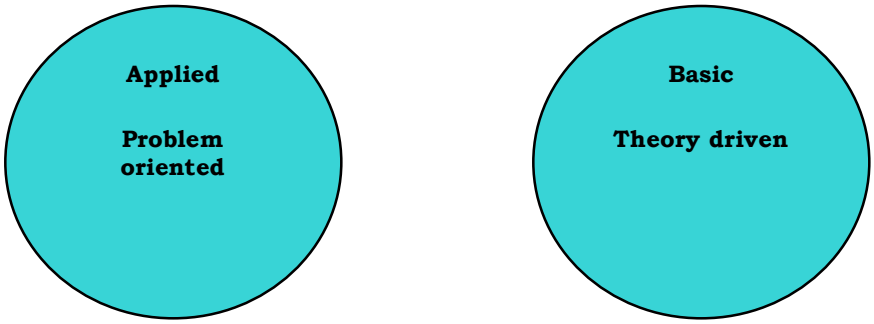
Are We Asking the Wrong Question?

Are we focusing on efficacy research when we should be investing in theory driven research?

Credibility Assessment

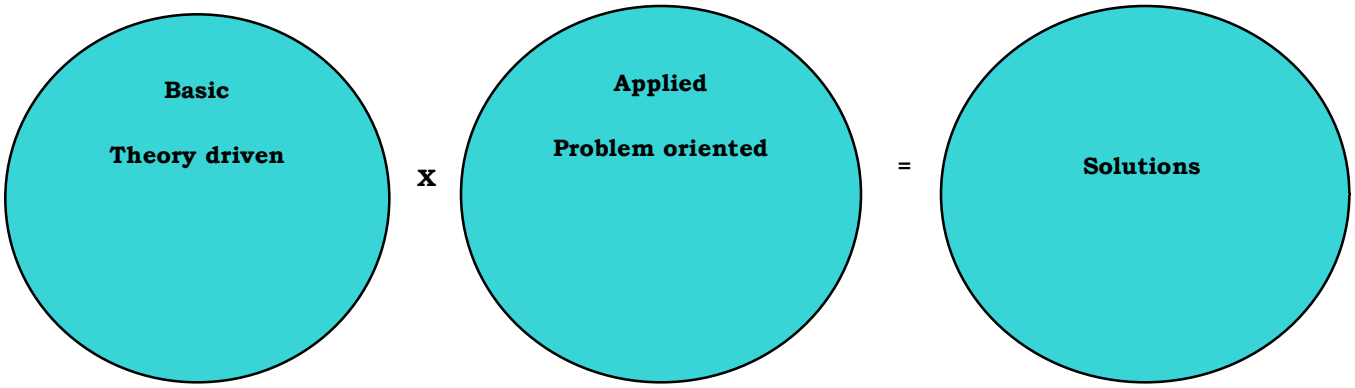


Credibility Assessment:
One Nervous System – Two Research approaches



Efficacy ***Mechanism***

Credibility Assessment:
The goal of translation research



How basic science can contribute to credibility assessment

1. Understanding neural processes
2. Theories of deception and credibility that are nervous system based
3. Translation of theory driven research to applications in the field
   a. Credibility
   b. Stress
   c. Pathology
   d. Work environment
   e. Medicine
   f. Social environment

What Do the New Technologies Provide?

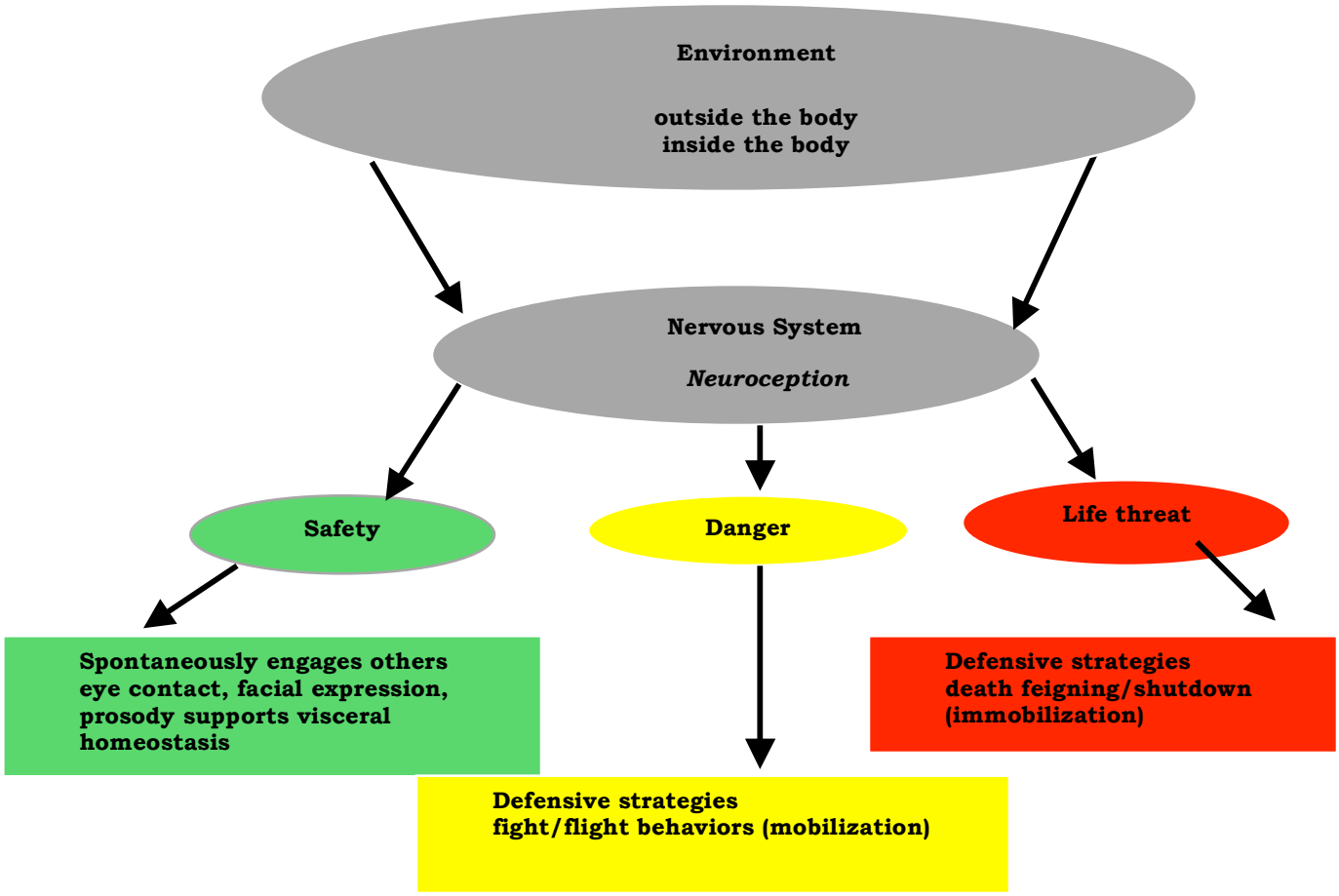
1. fMRI – basic mechanisms of how brain structures are involved in deception. Limited applications and paradigms.
2. Voice stress analyzers – theory is not well developed and data are weak
3. Laser Doppler and facial thermography - potentially broad applications in field research leading to the development of a theory driven model of deception/credibility

The Polyvagal Theory and the Social Engagement System:
Insights into the psychophysiology of deception

Overview: The Polyvagal Theory

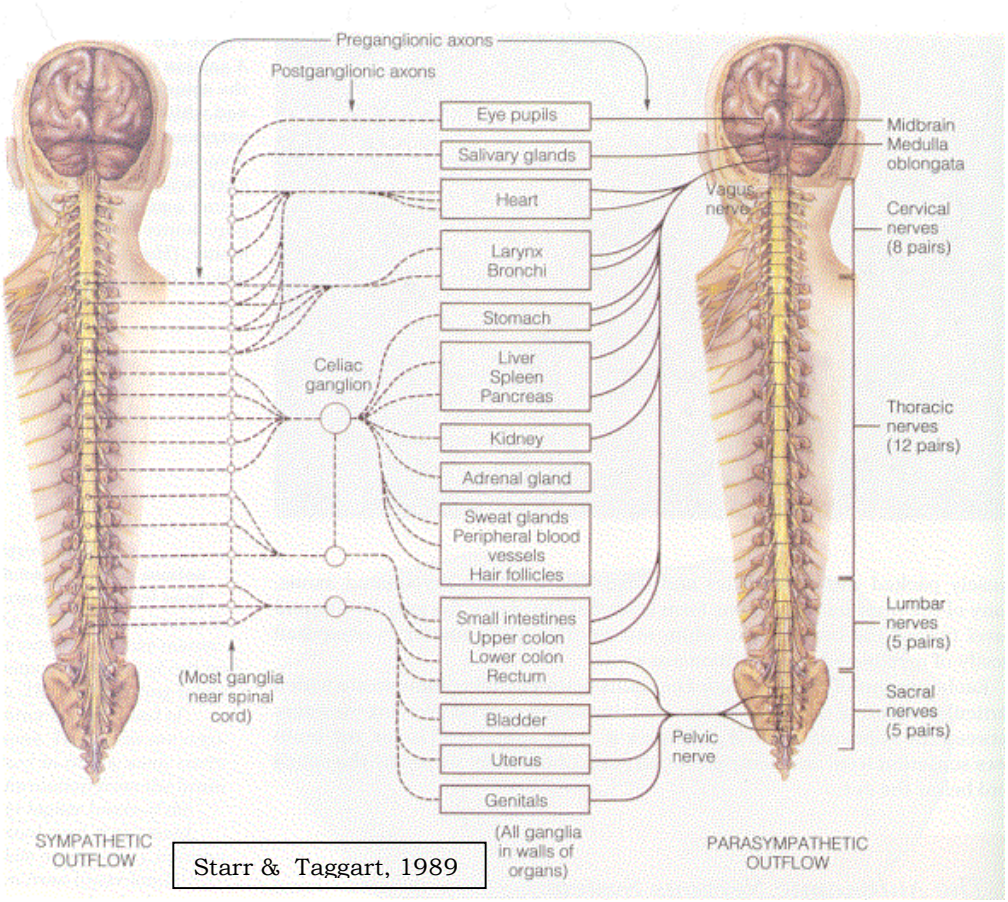
1. Evolution provides an *organizing principle* to understand neural regulation of the human autonomic nervous system.
2. Three neural circuits form a phylogenetically-ordered response hierarchy that regulate behavioral and physiological adaptation to safe, dangerous, and life threatening environments.
3. *"*Neuroception*"* of danger or safety or life threat trigger these adaptive neural circuits.

The metaphor of safety: A basic principle of our nervous system



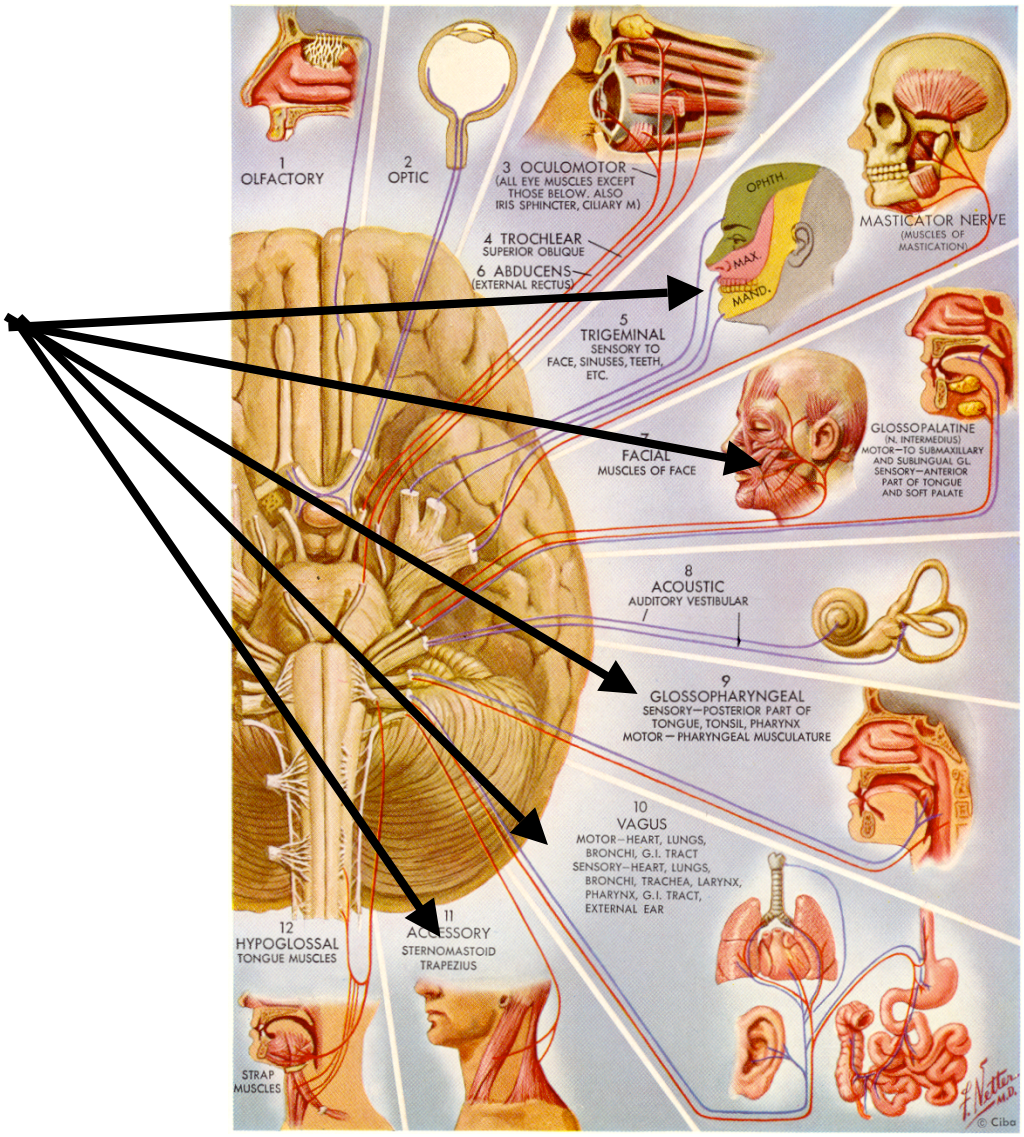
1. NOT Autonomic measures, but measures of the Autonomic NERVOUS SYSTEM
2. Characteristics of measures of the ANS
    a. Not merely arousal (SNS)
    b. Neural pathways
    c. Rhythmic features

Structures of the Nervous System: The Autonomic Nervous System



Starr & Taggart, 1989

Cranial Nerves:
"Stress" Reactivity



Evolution

Neural Regulation of the Heart in Vertebrates

	CHM	DMX	SNS	AD/m	NA
Cyclostomes	**X+**				
Elasmobranchs	**X+**	**X-**			
Teleosts	**X+**	**X-**	**X+**		
Amphibians	**X+**	**X-**	**X+**		
Reptiles	**X+**	**X-**	**X+**	**X+**	
Mammals	**X+**	**X-**	**X+**	**X+**	**X-**

Polyvagal Theory:
Three Adaptive Neural Circuits

	VVC	SNS	DVC
heart rate	+ / -	+	-
bronchi	+ / -	+	-
gastrointestinal		-	+
vasoconstriction		+	
sweat		+	
adrenal medulla		+	
tears	+ / -		
vocalization	+ / -		
facial muscles	+ / -		
eyelids	+ / -		
middle ear muscles	+ / -		

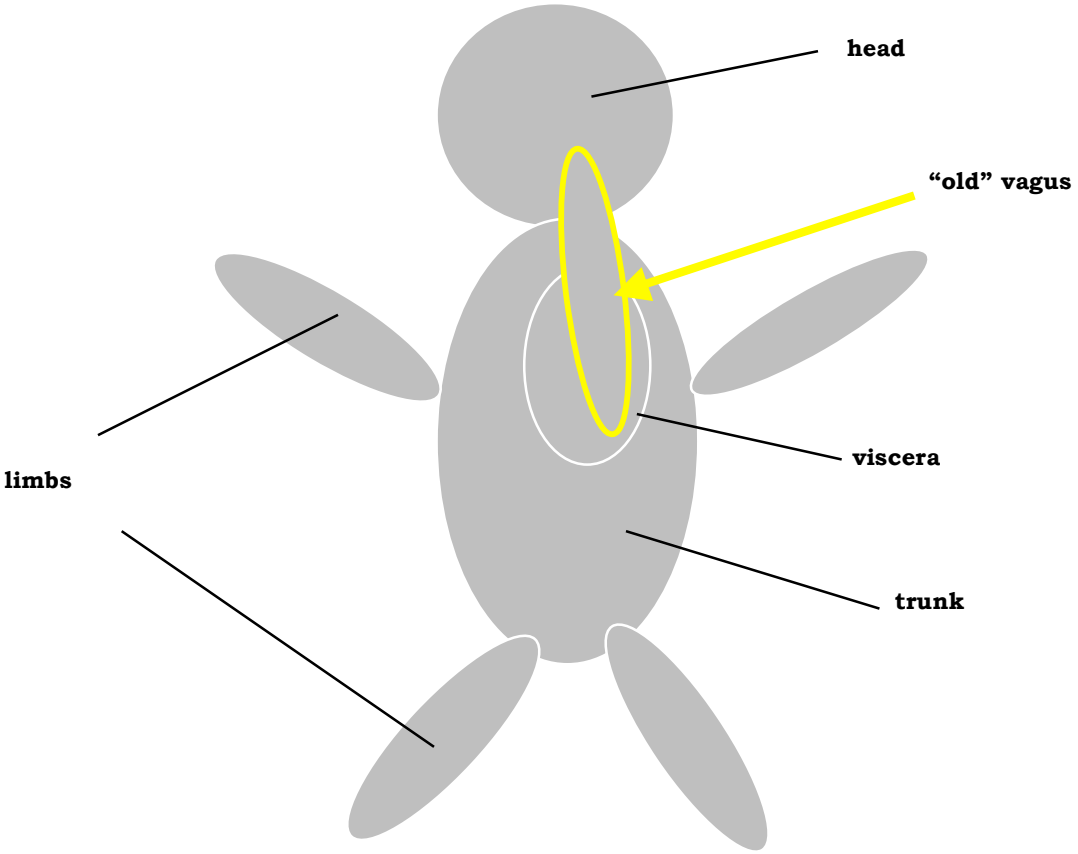
Polyvagal Theory: Phylogenetic Stages of Neural Control

Stage	ANS Component	Behavioral Function	Lower motor neurons
III	Myelinated vagus ***(VVC – ventral vagal complex)***	Social communication, self-soothing and calming, inhibit sympathetic-adrenal influences	Nucleus ambiguus
II	Sympathetic-adrenal system	Mobilization(active avoidance)	Spinal cord
I	Unmeyelinated vagus ***(DVC – dorsal vagal complex)***	Immobilization(death feigning, passive avoidance)	Dorsal motor nucleus of the vagus

Polyvagal Theory: A Phylogenetic Hierarchy of Response Strategies

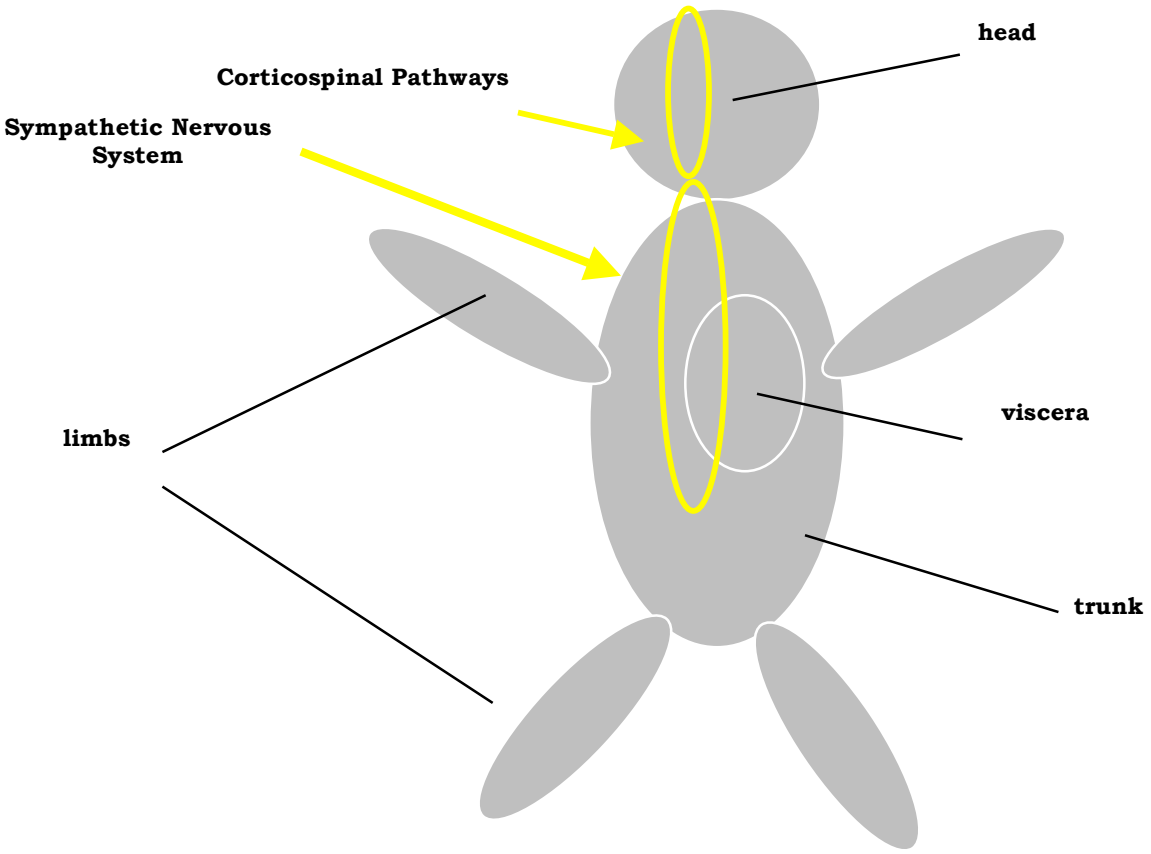
Structure	Function	VVC	SNS	DMX
Head	Communication	+		
Limbs	Mobilization		+	
Viscera	Immobilization			+

Phylogenetic Organization of the ANS: The Polyvagal Theory



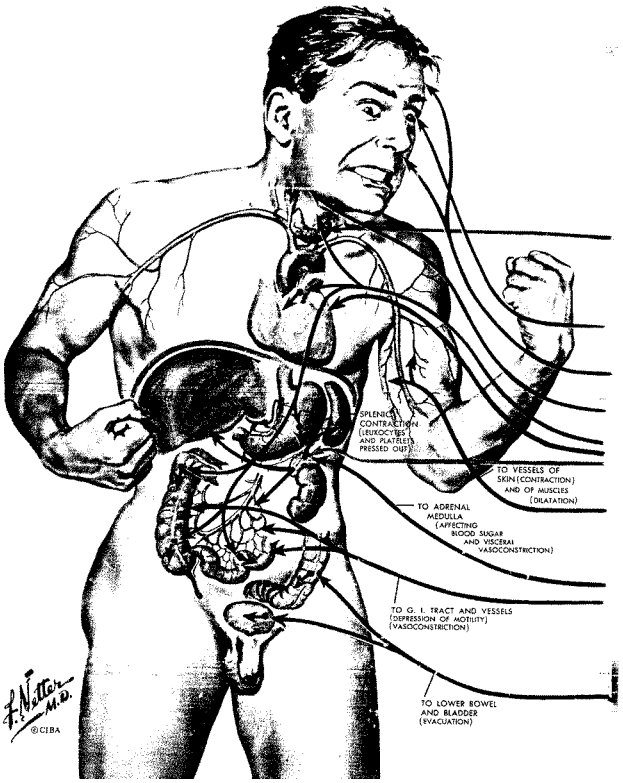
Vasovagal Syncope

Phylogenetic Organization of the ANS: The Polyvagal Theory

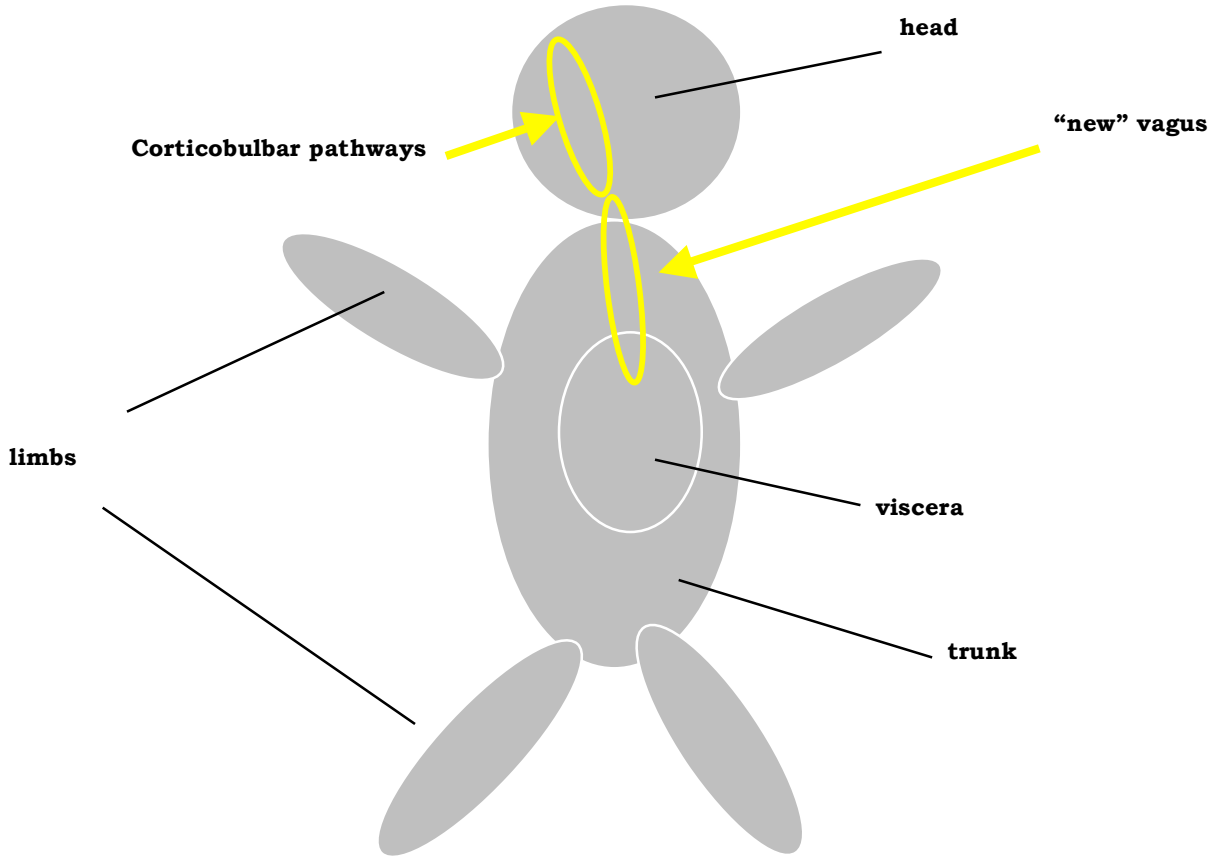


Mobilization: Flight Behaviors

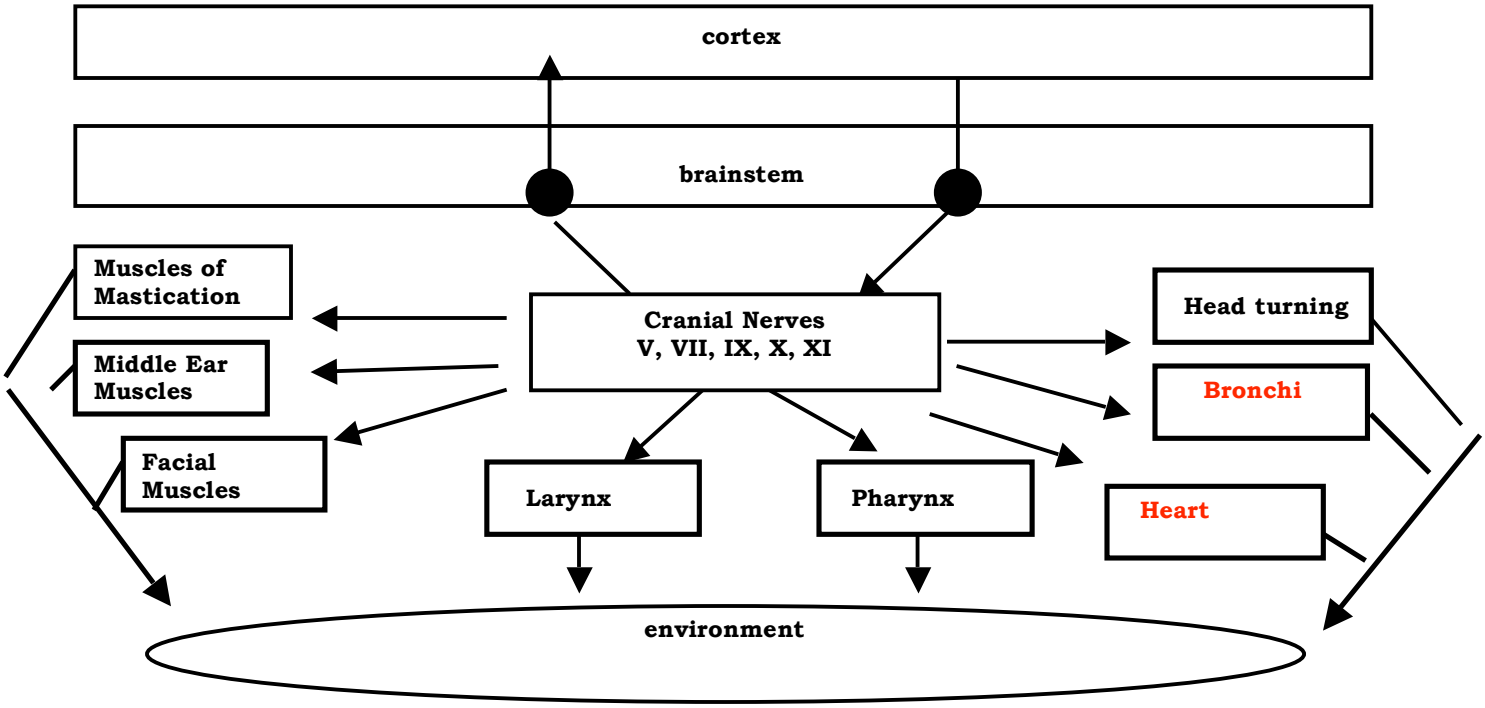
Mobilization: Fight Behaviors



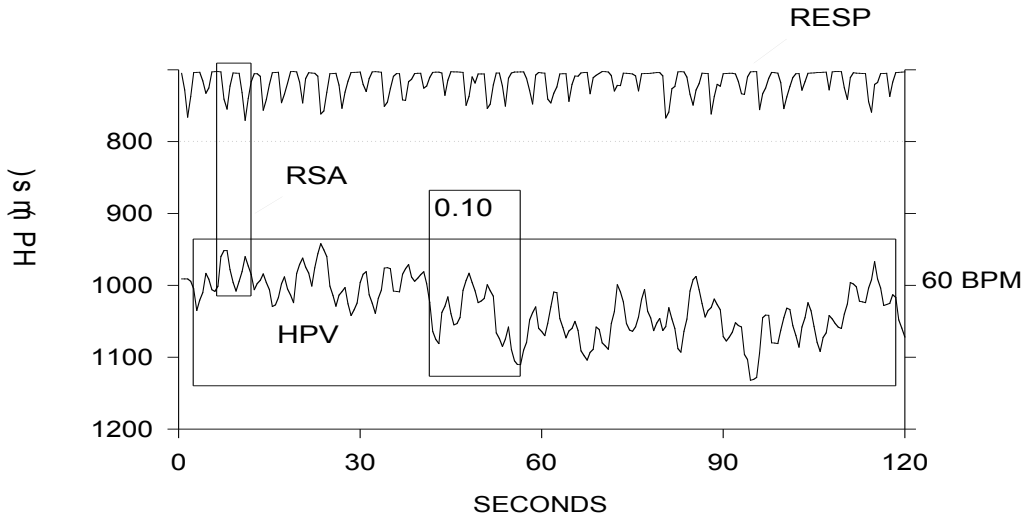
Phylogenetic Organization of the ANS: The Polyvagal Theory



Social Engagement System
Anatomical basis



Heart Rate Rhythms:
A measure of the "new" vagus

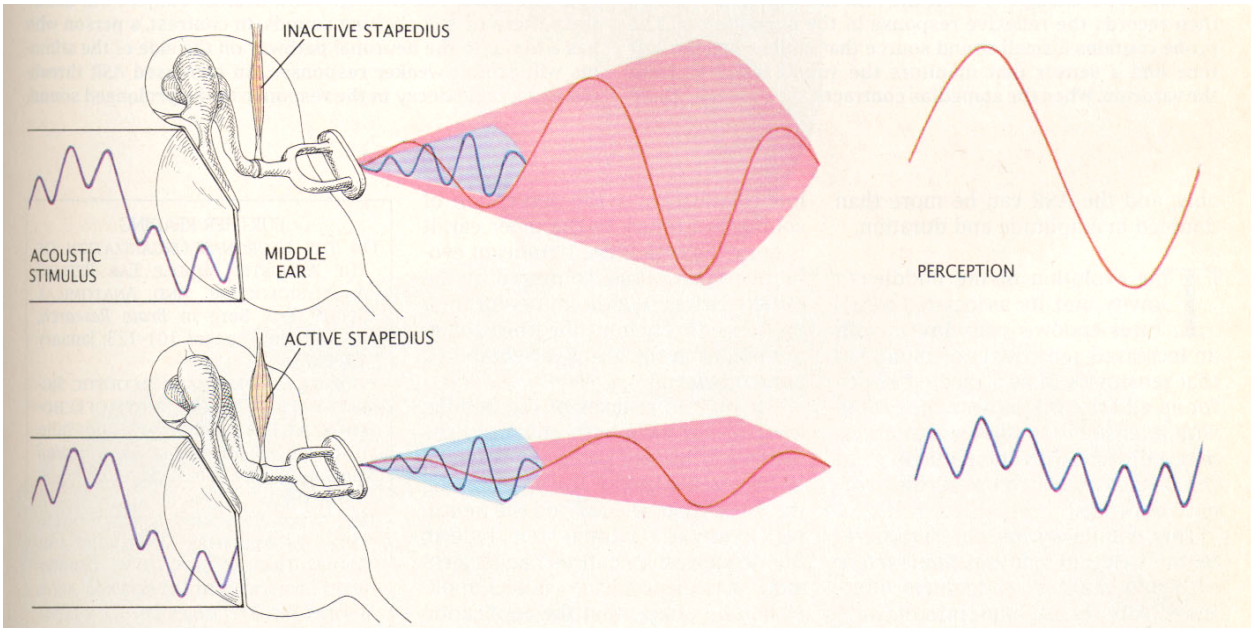


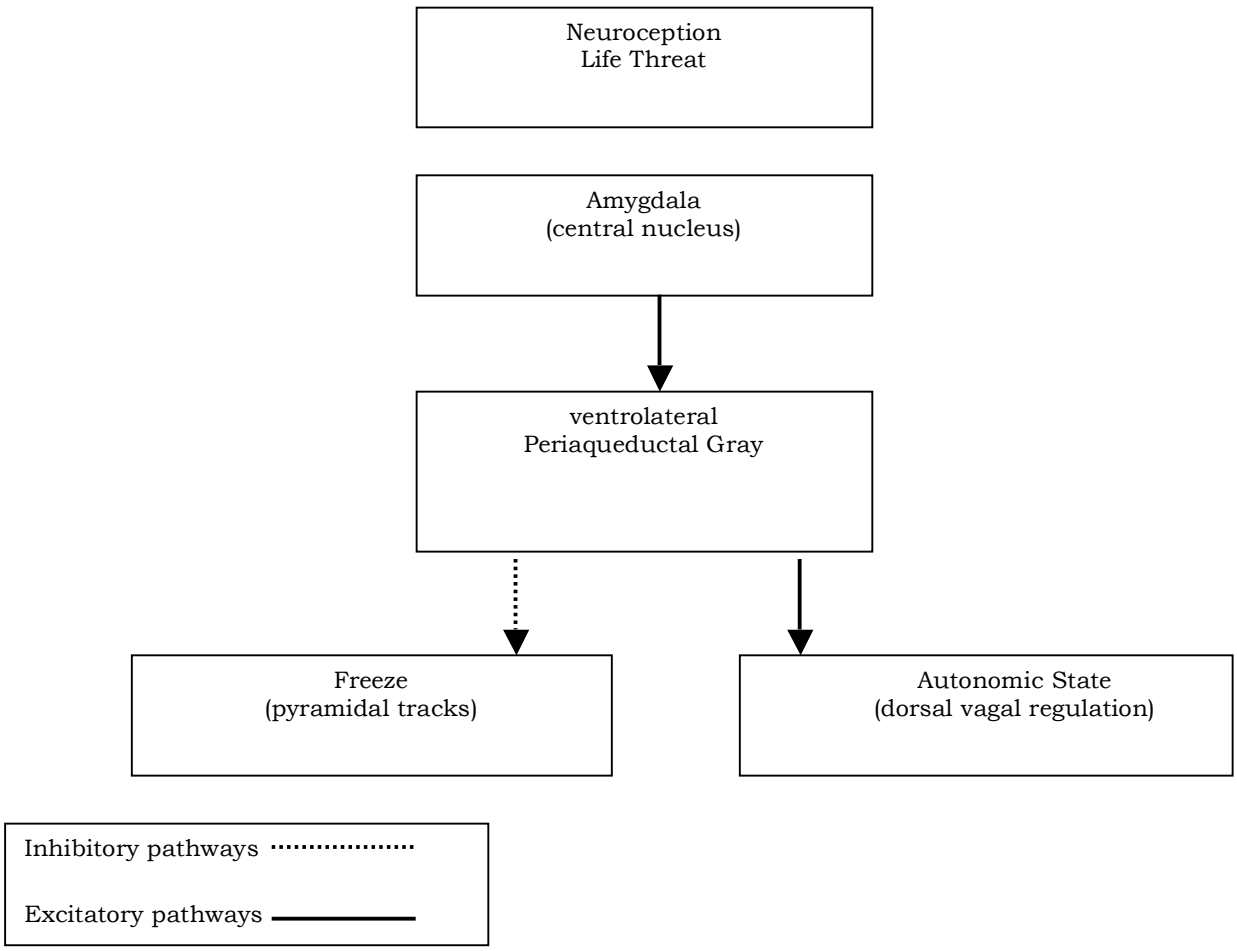
Autonomic Response Indicator System

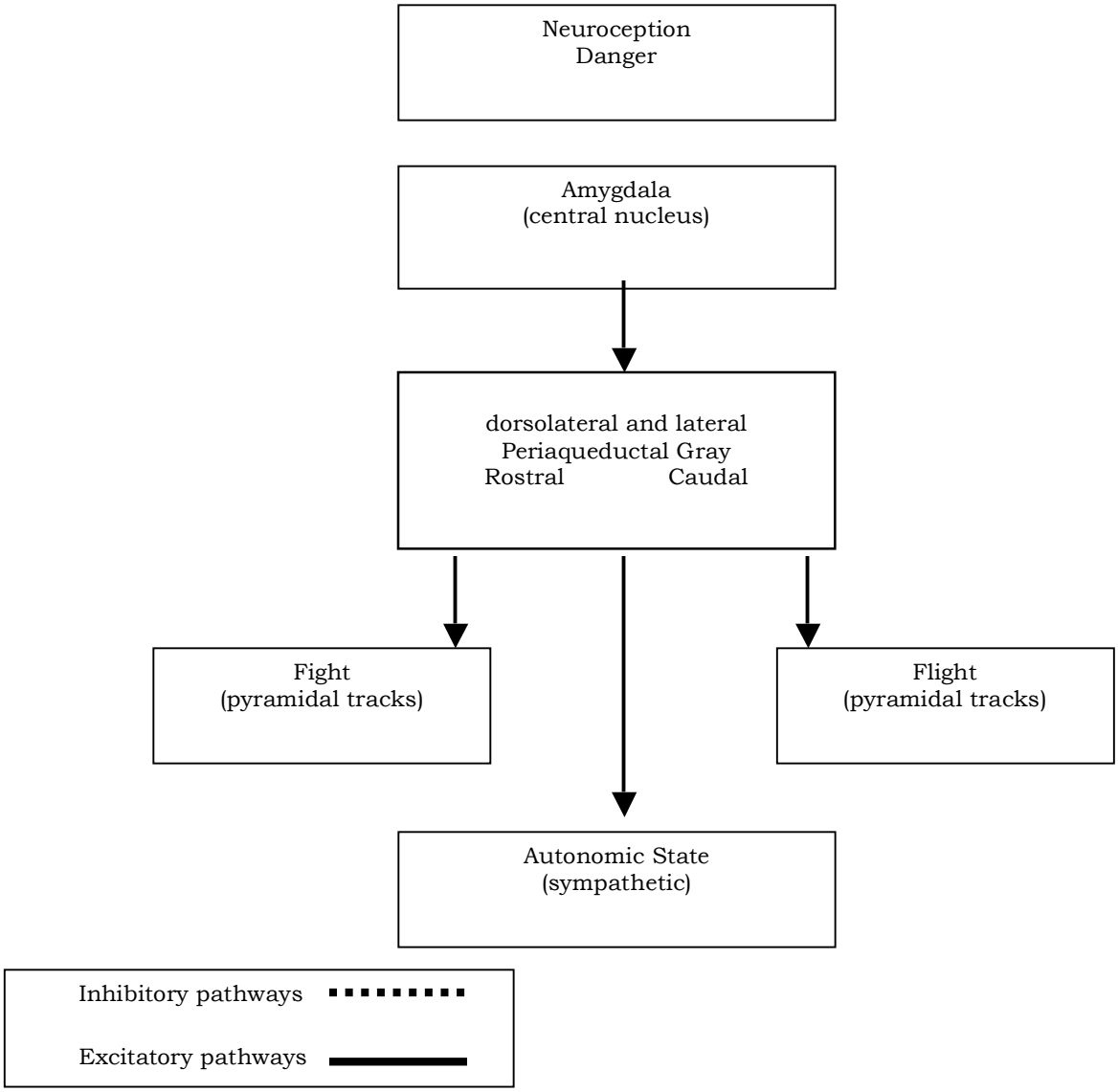
Input Signal	Derived Variable
1. ECG	HR, HRV, Q-T, RSA, CIDF, THM-A
2. Respiration	Rate, tidal volume
3. Blood pressure (finger)	Systolic, diastolic, BP variability (respiration, THM)
4. Activity (accelerometer)	Movement
5. ECG/Blood pressure	Baroreceptor sensitivity, pulse transit time

Looking and Listening: Common Neurophysiological Mechanisms

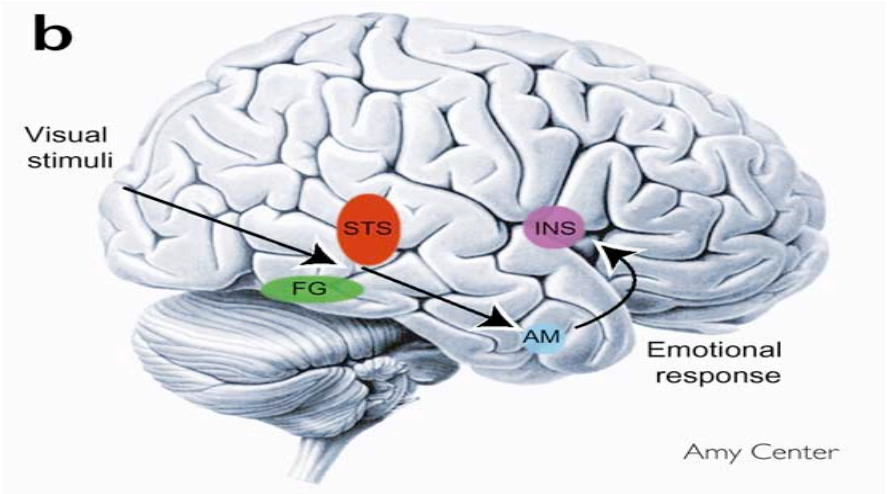
Middle Ear Muscles:
Role in Extracting Human Voice



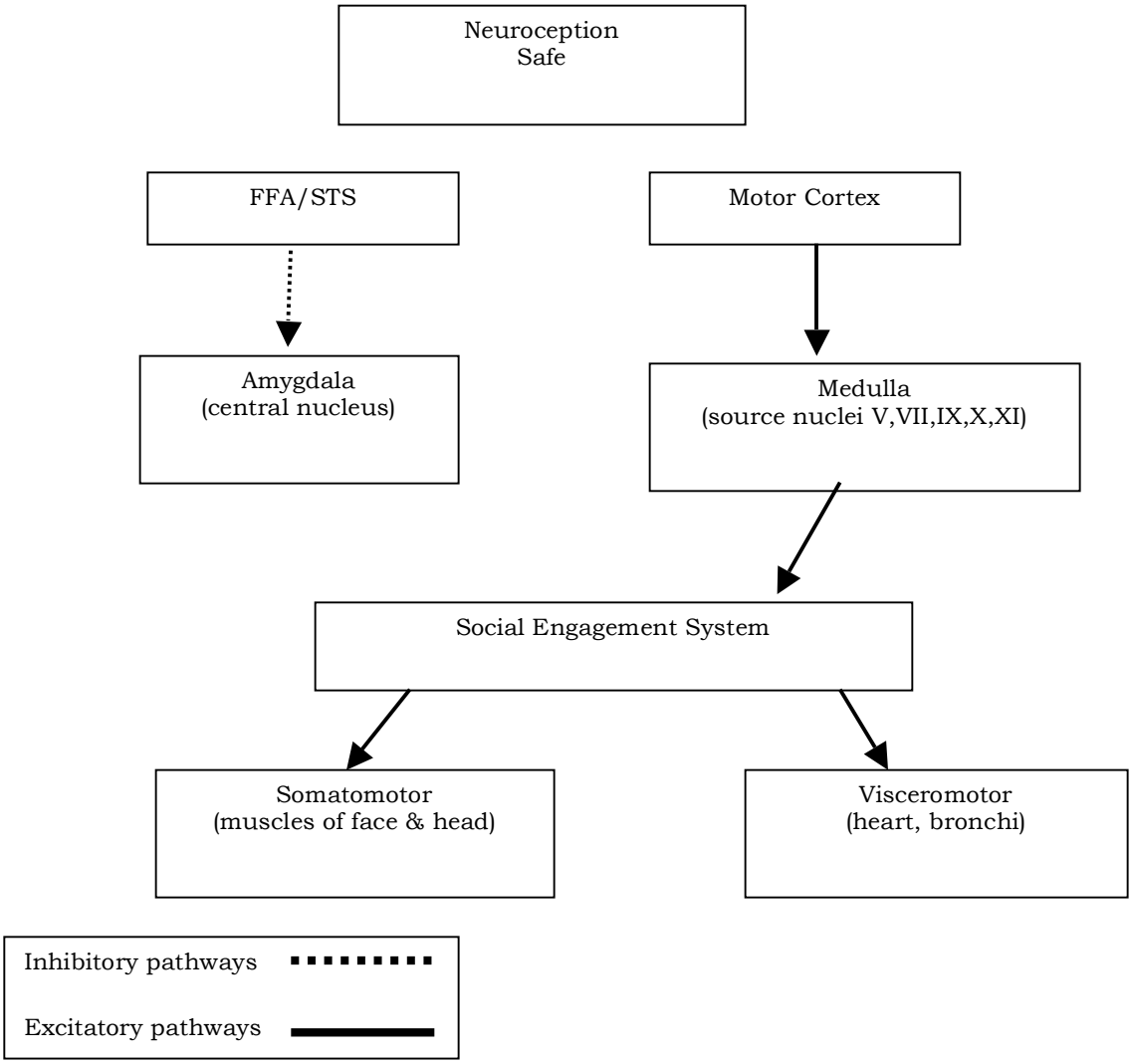




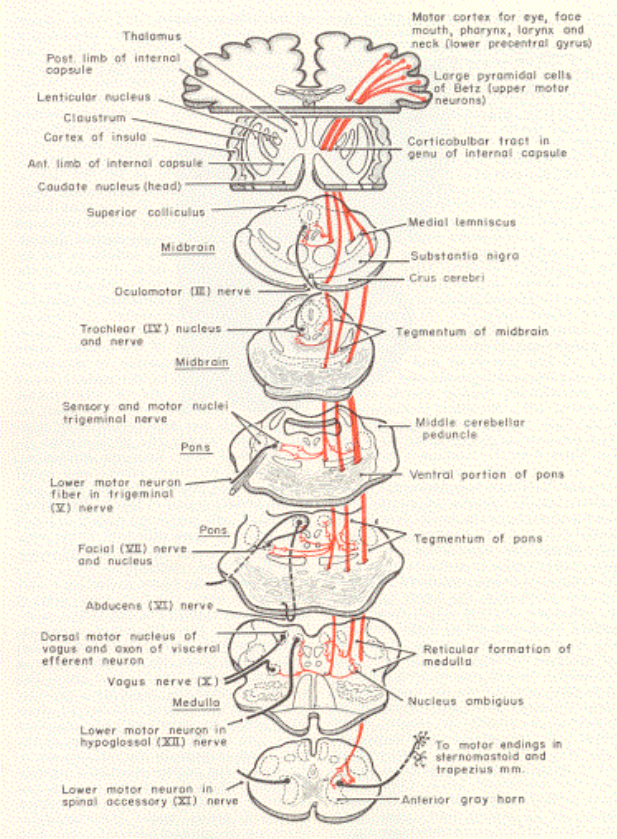
The Trustworthiness of Faces



R. Adolphs, 2002


Neuroception
Safe
FFA/STS
Motor Cortex
Amygdala
(central nucleus)
Medulla
(source nuclei V,VII,IX,X,XI)
Social Engagement System
Somatomotor
(muscles of face & head)
Visceromotor
(heart, bronchi)
Inhibitory pathways
Excitatory pathways

Corticobulbar Pathways



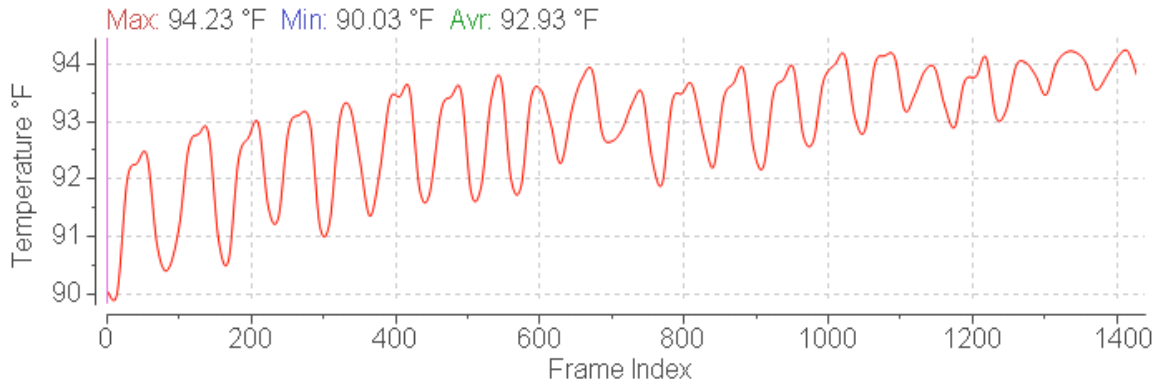
Social Engagement System:
Candidate variables for the detection of deception

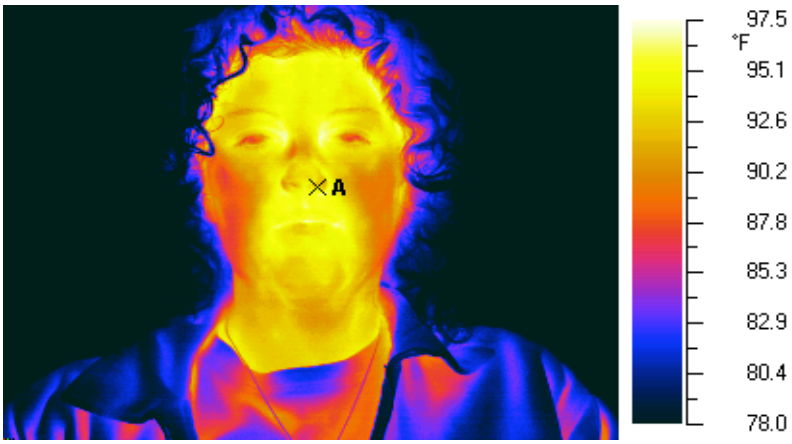
- Prosody
- Gaze
- Facial expressivity
- Autonomic measures (visceral state)
- Posture during social engagement

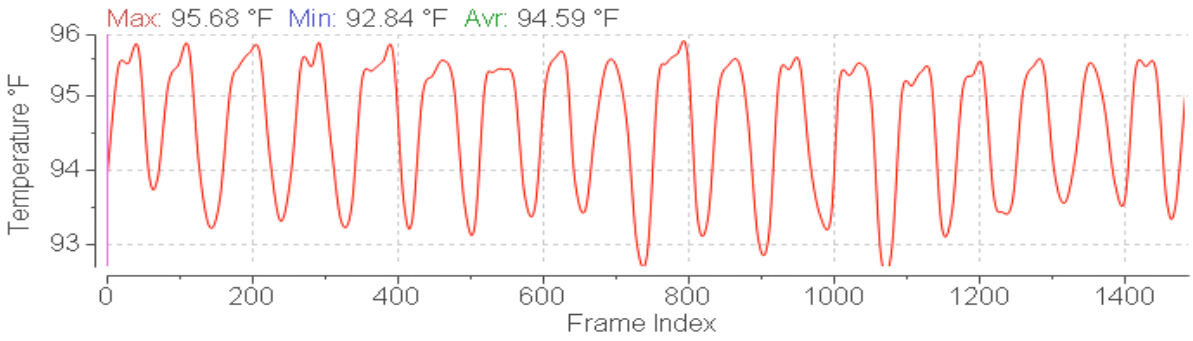
Social Engagement System
Where to look? What to measure?

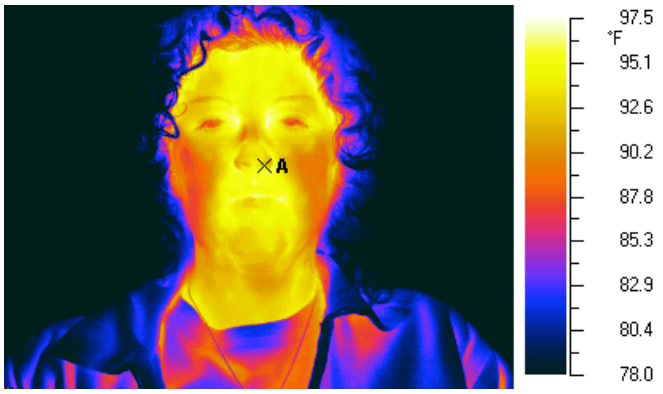
Cortex	ERP, EEG, EOP, fMRI
Autonomic	***heart rate, vagal tone (RSA),*** respiration
Middle ear muscles	impedance ***words from noise***
Facial muscles	facial EMG, thermography, video coding of faces
Laryngeal/pharyngeal muscles	acoustic properties of vocalizations, language
Gaze	***eye tracking***

The drift in temperature seen here is NOT due to actual temperature changes in respiratory flow temperatures…







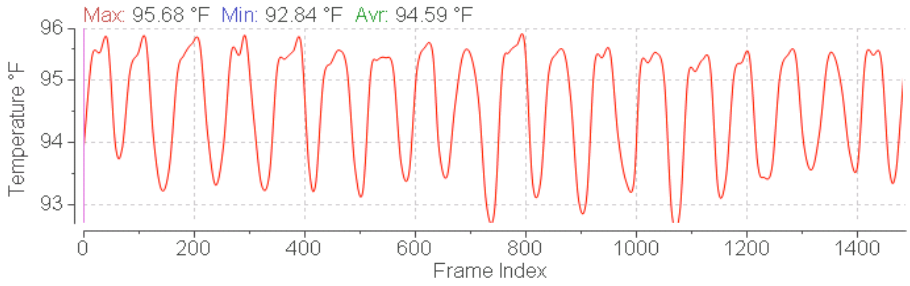


Respiration

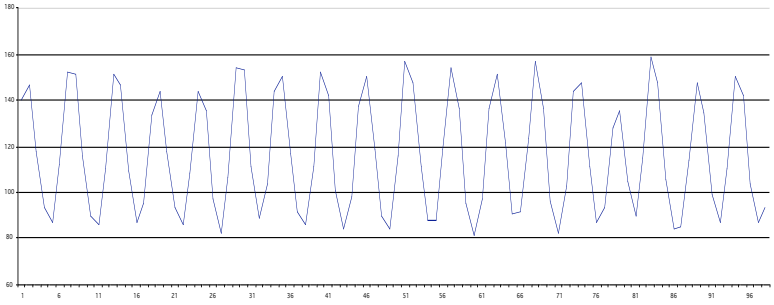
Respiration rate comparison: remote IR thermography vs. contact impedance pneumography.

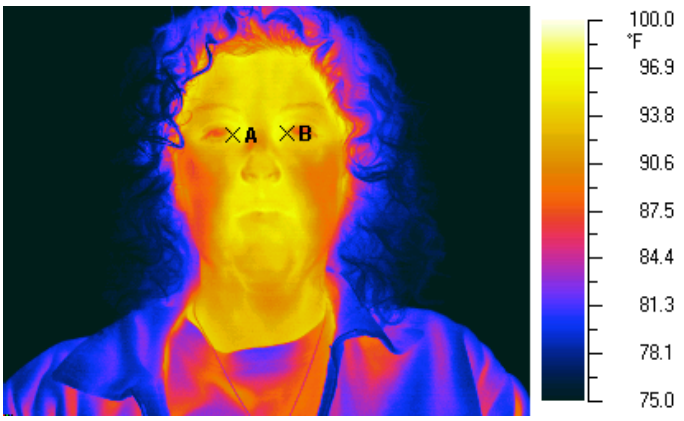
Respiration rate for each method = 21 breaths per minute

Respiration pattern via IR thermal pattern at the nasal passage



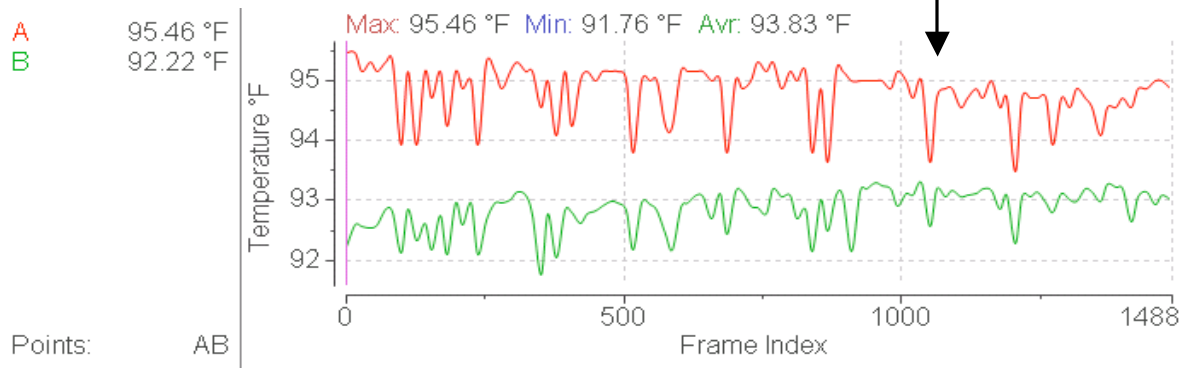
Respiration pattern via standard impedance pneumograph



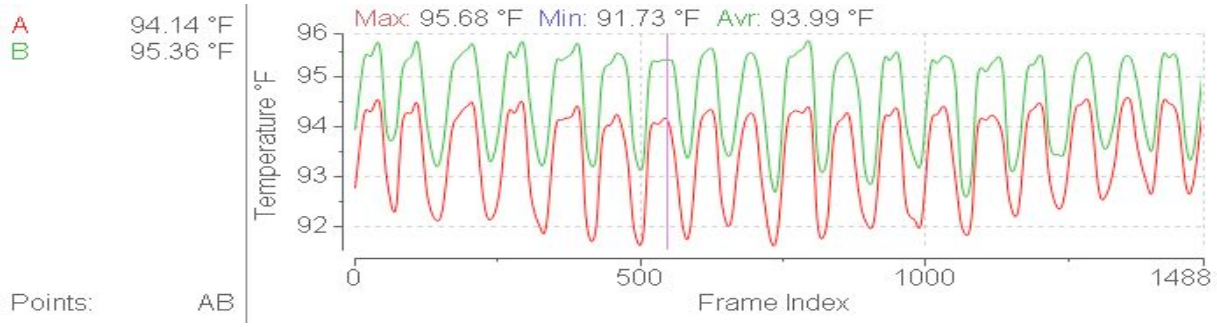


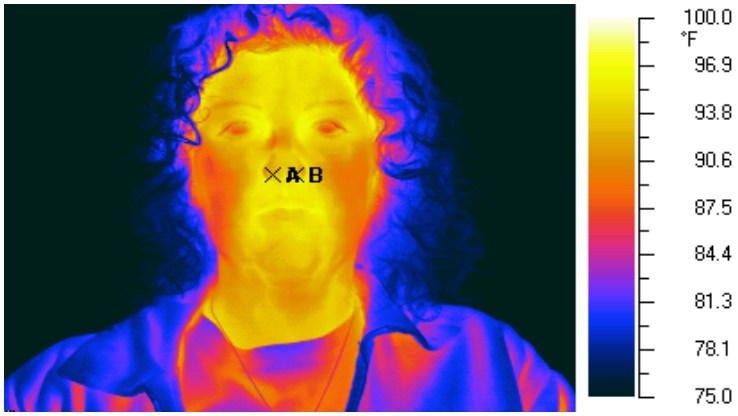
Blink Capture

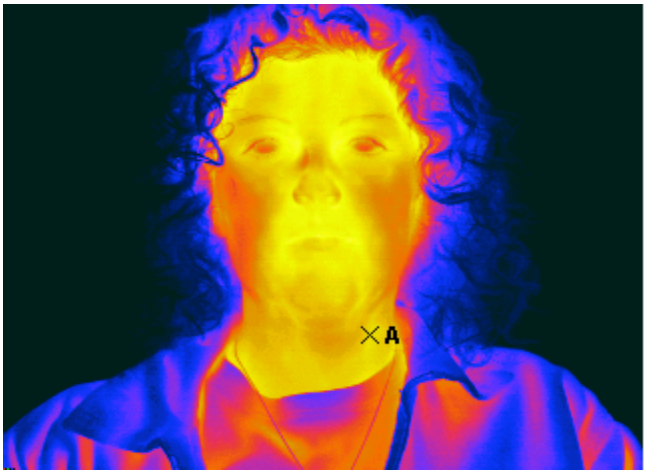
Negative temperature spikes reflect a blink captured by the change in temperature when the eyelid closes over the tear duct



Laterality



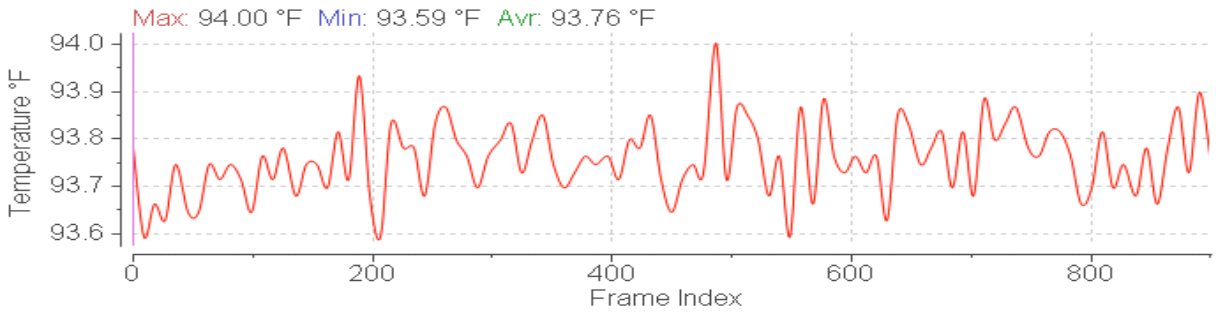


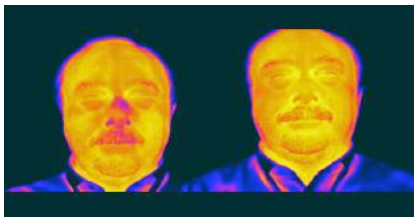


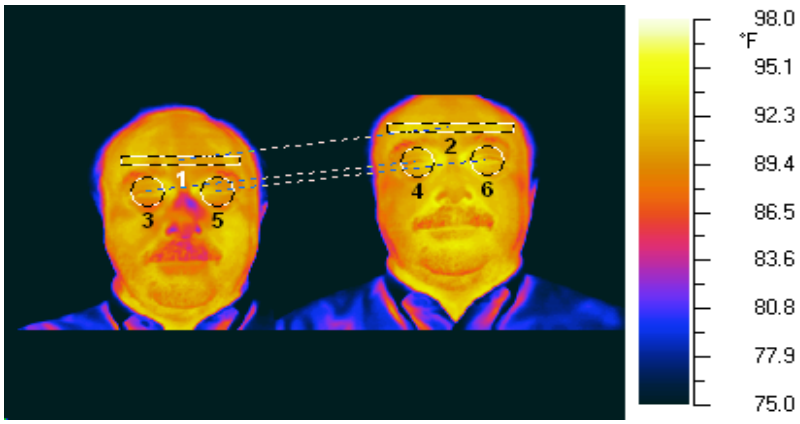
Heart Rate

Carotid Data

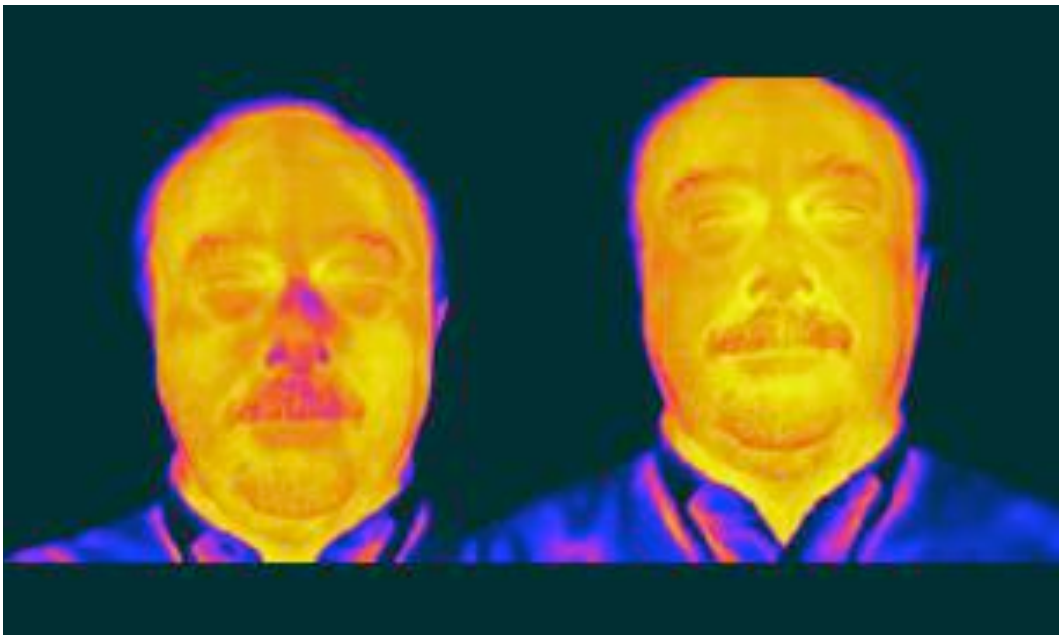
- 30 seconds (900 frames)
- ~38 spikes
- ~76 BPM

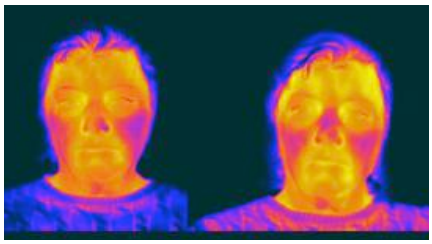


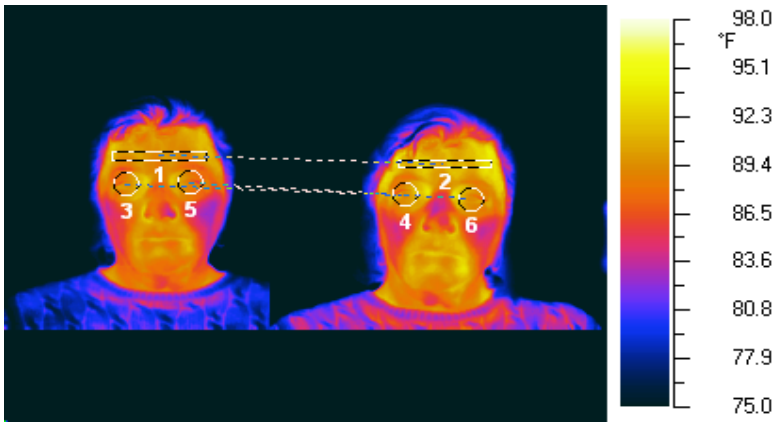




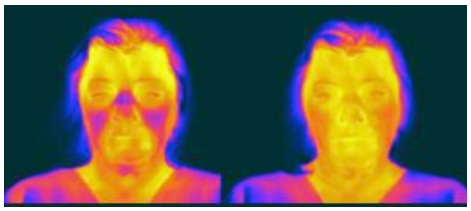
Area	Min	Max	Avg
1	89.66	92.45	90.81
2	90.19	93.29	92.07
3	87.46	92.76	90.09
4	87.96	94.33	91.17
5	87.93	92.60	90.11
6	88.72	94.14	91.27
delta 1-2	.53	.85	1.26
delta 3-4	.50	1.57	1.08
delta 5-6	.79	1.53	1.16

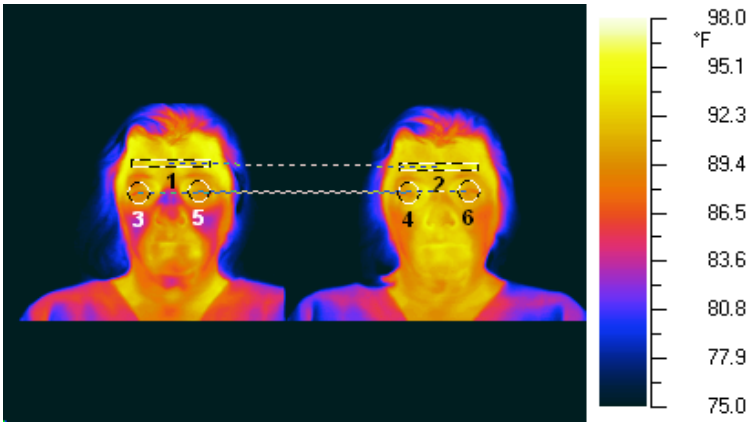






Area	Min	Max	Avg
1	88.09	91.68	89.70
2	90.13	93.68	91.52
3	86.35	92.14	89.38
4	86.85	92.33	89.83
5	85.08	90.90	88.56
6	86.67	92.60	89.77
delta 1-2	2.03	2.00	1.82
delta 3-4	.5	.19	.45
delta 5-6	1.59	1.70	1.2





Area	Min	Max	Avg
1	91.24	95.23	92.94
2	92.33	94.95	93.55
3	86.39	92.02	89.53
4	87.81	92.94	90.60
5	85.91	92.63	89.88
6	88.12	92.48	90.45
delta 1-2	1.09	.28	.62
delta 3-4	1.42	.92	1.08
delta 5-6	2.21	.15	.57

Biological Organizing Principles

- Facilitate an understanding of the neural mechanisms and contexts mediating autonomic reactivity
- Identify candidate variables for detecting deception

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