# Resilience, Flexibility and Neurotechnology Training:

Using the Intrinsic Self-Organizing Wisdom of the Central Nervous System

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### The Intrinsic Self Organizing Wisdom of the CNS

- The CNS is primarily designed for two purposes:
  - To detect difference
  - To reduce its own discomfort
- It is these two functions that allow us to provide any form of feedback-based training
- These actions allow the CNS to learn and demonstrate clearly that it is fundamentally an information processing system

### The Intrinsic Self Organizing Wisdom of the CNS

- The CNS does not need to be taught how to regulate itself, it already knows how to or we can't do feedback
- Feedback doesn't give or create capabilities that are not already intrinsic to the CNS
- Rather neurofeedback training processes restore access to already established psychophysiological possibilities
- We don't teach the CNS to relax, we help it remember what it already knows and does so it can relax more easily

#### Learning is an informationrich feedback process that opens up degrees of freedom

Grounded in perception, memory and oriented towards increasing resilience and flexibility, learning adaptively extends inherent capabilities based on perceived differences in the environment

#### Detecting Difference is a Perceptual Process

- Not just sensation
- But includes memory
- And lived orientation to what is useful, enjoyable, disliked, etc
- So let's ask: what is really needed to detect difference?
  And how is that different from just noticing something?

### Detecting Difference is a Perceptual Process

- A user recently reported their experience in noticing that the fan for their HVAC system was on continuously
- What did that CNS have to do to determine that?
  - 1. Notice the sound of the fan (which was NOT novel)
  - 2. Maintain lived memories of prior experiences of that sound, including that those experiences ended
  - 3. Compare in some way the current ongoing experience with those memories, esp re: duration

### Detecting Difference is a whole body experience

- Maurice Merleau-Ponty talked about the Primacy of Perception, viz that perception is a lived body experience that is information rich (as we would say today), unfolding within an environment filled with what he called "Lines of Force" that orient us unawarefully
- Perception is a second order neuropsychological function (Luria) so global in organization, holographic in implementation
- Difference quite literally "stands out" (ex-sistere) in that environment as being discrepant, like a sore thumb
- A sore thumb "sticks out" because it has compromised resilience and flexibility of the hand and "gets in our way"

### Tools "fade away" becoming part of the hand using them

- You don't "swing a hammer" to "hit a nail"; rather, you "hammer a nail" as one integrated action pattern
- At least you do after you've learned that pattern
- Each hammering act is unique yet similar to all other hammering acts: Wittgenstein's "Family Resemblance"
- The more complex the tool and task, the more unique each iteration becomes while still remaining "similar"
- Hammering comes to embody resilience and flexibility

### We only notice the tool when it fails, by it getting in the way

- When we have a sore thumb we can't wield the hammer easily, fluidly, or effectively, let alone artfully
- The sore thumb literally doesn't have the resilience or flexibility to adapt to the moving hammer nor to the unique demands of THIS current nail as it is hammered
- Because of that "extrinsic constraint" I slow down my actions and think about what I'm doing....a lot!
- And that can become frustrating as well as painful

#### Self-Organizing Criticality

"Self-organized criticality (SOC) is a property of <u>clynamical systems</u> which have a <u>critical point</u> as an <u>attractor</u>. Their macroscopic behaviour thus displays the spatial and/or temporal <u>scale-</u> <u>invariance</u> characteristic of the <u>critical point</u> of a <u>phase transition</u>, but without the need to tune control parameters to precise values." <u>http://en.wikipedia.org/wiki/Self-</u> organized\_criticality

### The Sore Thumb "Emerges" in Such a Critical Point

Having a sore thumb intrude involves such a phase shift in the overall system, maintaining "scale invariance" without having to specify ahead of time "how sore sore is".

Virtually all transformative shifts in behavior can be understood in this way

I won't go into the details of that but simply want to point out that change is a non-linear, dynamical process. A little more of the precursor does not yield an equivalent "more" of the derived change

### The CNS seeks to reduce its discomfort

- This is "scale invariant" and takes precedence over increasing comfort, this is why according to Tomkins we have so many more "negative affects" than positive or neutral ones: ie it's more adaptive for the species
- Discomfort also "sticks out" just like a sore thumb
- And what makes the thumb "stick out" in the lived world is that it isn't resilient and flexible and we perceive and experience that difference against memories of flow in similarly "scaled" phenomena

So why are resilience and flexibility so critical?

#### Homeodynamics not Homeostasis

- From Bernard: "Multicellular organisms reveal a tendency towards returning to the stability/regularity of the always changing but continuing milieu interieur (internal environment)...such that most of the work they do is oriented towards regulating this continuity."
- The CNS manifests a multitrend process of relative continuity that is always different yet also always self-similar unless a catastrophic deformation occurs
- Even when that happens the deformation itself is crystallized within some remnants of the prior homeodynamics: like the sore thumb and hammering nails become part of me who hammers

Resilence and Flexibility allow us to literally navigate life efficiently and effectively

They allow us to "reach out" and "reach into" the world to caress it and allow its richness to support, nourish and educate us

Resilence and Flexibility are the processes that allow us to maintain homeodynamic structure even when "things go wrong"

Like when discomfort begins to pervade our lives, constricting our degrees of freedom, robbing our lives of joy, compassion, and connection

### Resilence and Flexibility in locomotion

- Consider what happens in Parkinson's as mobility is increasingly compromised
- Walking loses its elasticity and becomes a stereotypic pattern of "averaged" steps that are all the same
- The moving body does not adapt to its terrain, the foot doesn't flex/extend as it reaches out to find the floor and accept its support and accommodate to gravity
- Robotic legs must move slowly for this reason: ie, they are "disordered" by being so "averaged" in execution

What we call "Disorders" are highly stereotyped, inelegant, unuseful patterns: they are crystallatizations

They are actually hyper-orderly and we know that transformation is beginning when we start to see unpredictable responses instead of simple repetition of non-successful patterns However "Disorders" also "hide" very important information from the Client

Most notably that the behavior patterns aren't working that well. Instead they are "seen" as "just being me" and no useful information about how they occur appears to the Client And Disorders require a lot of energy and work to maintain: we don't "have" them we literally **DO** them

Change is the basis of reality. Keeping something repeating in the same way is very difficult and requires very precise actions in particular sequences How can we maximally help the CNS to restore its intrinsic chaos, resilience & flexibility

 By giving it real-time information in its own language about its own processing and allowing it to adapt and accommodate to that information in its own way

 Just like it did during early childhood as it explored its environment, discovering the lines of force and lived meaning of walking

Sara teaching herself to walk

### Information is embedded in difference that is perceived

- It isn't "reduction of uncertainty", at least not for humans, nor is it "novelty"
- Rather, as Denis Gabor observed, information always involves usefulness: ie if the "data" isn't useful to me in some way, then it isn't information for me, it's noise
- The CNS orients towards emergent differences in its environment because they literally "stick out" and if that difference isn't useful it is then ignored: it becomes data and just noise that is disregarded

#### Using the Orienting Response in Training

- By invoking the Orienting Response we also engage what Tomkins called "Neutral Affect".
- This change feels "less bad" and may even transition into curiosity or "Surprise/Startle" as, quite literally, new information appears
- I call this the Emily Latella shift others call it the "Aha" moment

#### The consciously recognized "Aha" is not that important

In fact it may not even occur

- But if behavioral change occurs then learning is possible, esp as the CNS perceives and then experiences the difference that emerges from the behavior change
- Interrupting the "descent into chaos" of the Trauma Response is very healing in and of itself because it changes the Trauma memory itself and this changes later perceptions of it, thereby, invoking an internal feedback learning loop regarding the whole ensemble, esp what maintains it

We don't have to specifically train the CNS to "do something" different in the time-frequency domain

We can simply interrupt the cascade -- by introducing a non-ignorable Difference into the environment -- and letting the CNS "close the loop" itself. The CNS is an energy conserving system

#### We don't have to "provoke", "push", or "pull" it towards what we believe "Normal" should be

- Instead we can comprehensively detect when such critical transitions are about to happen -- looking for turbulence throughout the entire time-frequency domain
- And signal only THAT the CNS is "on the cusp" of a critical transition, without providing information about the specific transition or time-frequency signatures involved
- This Invites the CNS back to the present, allowing it to, literally calm down and "sort itself out" in its own way

This is an inherently fail-safe, fault tolerant and gentle way to provide "self-correcting", "time-delayed" feedback to a self organizing system

Without regard to presenting complaint, diagnosis, condition, context of training and with no regard for what experience the Trainer has or doesn't have. In fact, this approach is entirely self-contained NeurOptimal® is the only system that implements this complete idea of self-regulation

Using unique, proprietary Joint Time-Frequency Analysis and Non-linear, Dynamical techniques it literally requires no expertise on the part of the Trainer, besides doing a hookup

### NeurOptimal® empowers anyone to train themselves

It is a completely automated, comprehensiveadaptive self-tuning system that adapts itself moment to moment to the "Client" and that CNS's response to the actual Training process itself.

## NeurOptimal® is diagnostically agnostic

- The "same" Training approach and Training sites are used for everyone
- The software individualizes the process to each person moment to moment throughout the Training session
- Using a comprehensive array of 16 uniquely tuned Targets, deployed symmetrically over 2 channels of EEG: 8 Targets for each channel
- Organized into 4 "Periods" of Training: we call ZenX Modes

#### What makes it possible to provide Training in such an individualized manner?

Painstaking analyses over the years of successful and "not" successful Training sessions across systems, across clients and trainers, pointed to a clear set of 16 time-frequency envelopes that were common to the successful sessions.

#### It's not "One Size Fits All"

Rather it's one comprehensive, adaptive "way of sizing" used across the entire time-frequency domain allowing the software itself to individualize the Training moment to moment to each CNS in that CNS's own unique transformative trajectory, restoring that CNS's access to its own intrinsic resilience and flexibility

#### NeurOptimal® Training Approach couldn't be easier

- Standard Hookup: C3 and C4 actives with ipsalateral ear references and a single ground earclip on right ear
- Standard length and sequence of Training: "Regular" Session involves sequencing automatically through the ZenX Modes (Warm Up, Stretch, Exercise, Cool Down)
- AutoNav fully tunes the process so there is no need to adjust "thresholds", change "filters" or target specific regions, etc
- Standard music, although any audiovisual resource can be used, depending on Client's preferences

#### Feedback Events are triggered automatically by Turbulence

- Excursions outside of the Turbulence Boundary (ie "Zone of Criticality") of any of the Time-Frequency Envelopes triggers a feedback event
- Each feedback event is an interruption in the ongoing audiovisual stream
- each interruption is subliminal, taking 3 or 4 contiguous interruptions to be "heard" by the Client

#### Client directions and actions

- Clients are instructed to not "do" anything
- Clients can have their eyes open or closed during the Training and can recline or not
- Clients can also engage in other activities like cognitive remediation, reading, playing video games, talking, etc

#### A Complete Training Session

- Begins with a Pre-Baseline of 30 seconds with Client looking at the Client screen for the first 15 seconds then closing eyes for the last 15 seconds
- Depending on Trainer and Client preference the Pre-Baseline can be explored and explained further or....
- Just begin the Training, which takes about 36 minutes
- Then perform a Post Baseline, just like the Pre-Baseline

#### Pre and Post Baselines can be used to track change across sessions

- Use the Baseline data to calculate the CCAC and its Divergence value
- Compare the Pre and Post Divergence values to derive the Divergence Difference for that session
- If Divergence Difference is a negative number then the CNS is returning to resilience and flexibility
- If it isn't then the session "stirred the pot" a bit, which can also be fine

The Client determines the usefulness of the Training, not the Trainer

It is the Client who sought out Training because of something the Client wanted to be different so the Client gets to determine when that happens This also means that there are no QEEGs, or other assessments performed

They are, at best, irrelevant to the neurofeedback Training Process itself: ie, no information about what to do differently in the Training itself will emerge from QEEGs or other assessments This also means that Clients can train themselves and others, including family members

The expertise is in the software. No specific training, experience or knowledge is needed to use the system successfully

This is because NeurOptimal® gives information TO the CNS and allows the CNS itself to determine what, when and how to change itself

In that sense NeurOptimal® truly incarnates the idea of self-regulation because Clients themselves regulate the entire Training process, accessing their own intrinsic capability of self-regulation in their own unique manner, with AutoNav adapting to **them** moment to moment

