Emerging Neurotechnologies: Practical and Ethical Issues at the Intersection of Brain Science and Society

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Neuroscience…

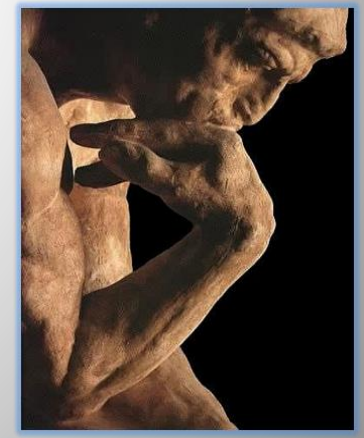
- **Huge leaps using technology to study and understand how nervous systems and brains are structured and function.**

Allowed understanding at certain levels of causality:

- **Formal: Overall "workings" of biological systems**
- **Material: Structure and functional roles of neurons, glia**

But *not* at others…

- **Efficient: How "grey stuff" actually makes "great stuff"**
- **Final: For what? To what "ends"?**



Core Questions...

What do we do *with*

the information and capability

we have?

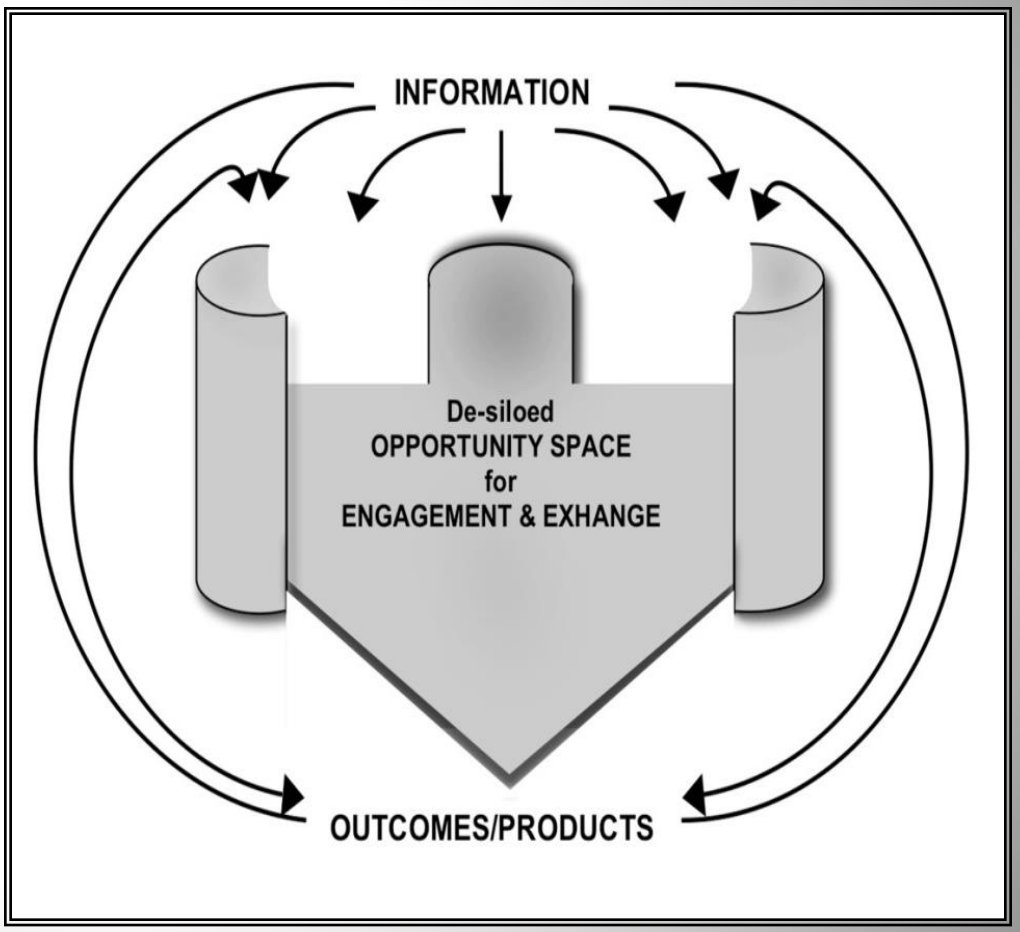
What do we do *about* the information and capability we don't?

Questions toward Innovation

- **Tools to Theory**
- **Theory to Tools...**

...to Theory

***AISC* Approach**



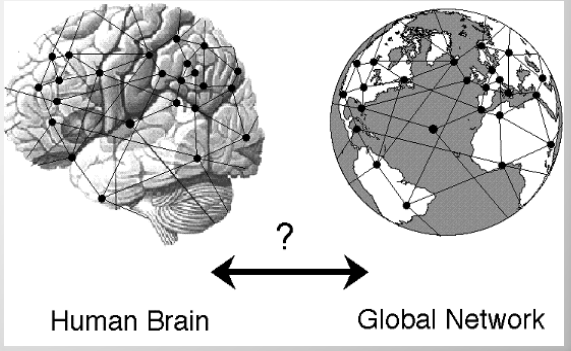
Brain Science on the World Stage

- EU *Human Brain Project*
- US BRAIN initiative
- China *Brain Project*
- *Japan Brain Project*

Human Brain Project

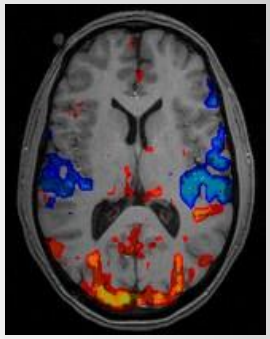
BRAIN INITIATIVE
BRAIN RESEARCH THROUGH ADVANCING INNOVATIVE NEUROTECHNOLOGIES

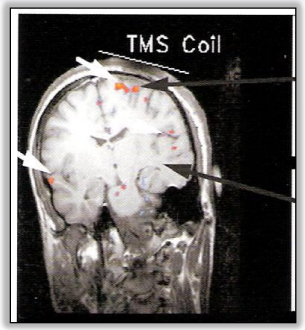
- Global NeuroS/T Economic Predictions 2025
  - Asia
  - US/Western Europe
  - South America

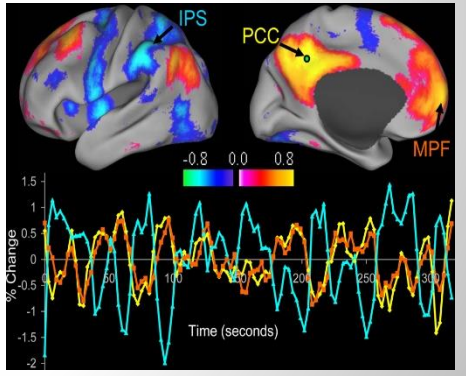


Neuroscience and Technologies (NeuroS/T)

- **Assessment**
  - Biomarkers
  - Genetics/genomics
  - Imaging
  - Brain modeling/mapping
- **Interventional**
  - Technopharmaceutics
  - P-Stim
  - Neurofeedback
  - Transcranial Modulation
  - Deep Brain Stimulation
  - BCI
  - Neuroprosthetics
- **Derivative**
  - -Artificial neural networks
  - -AI technologies



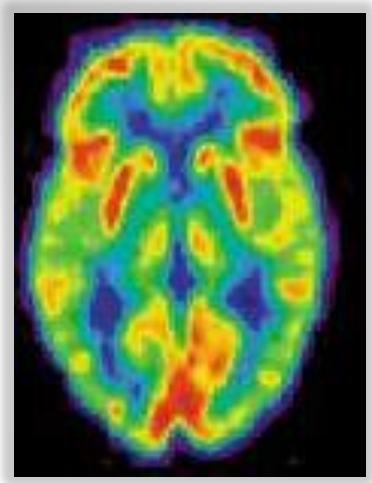


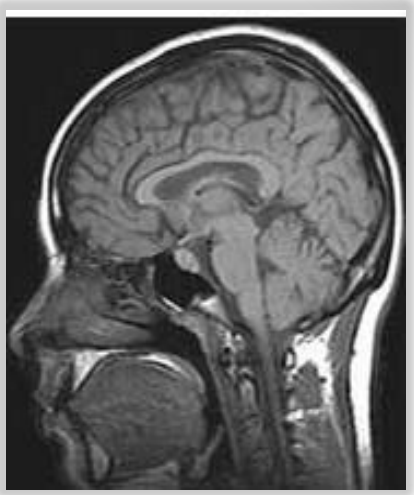


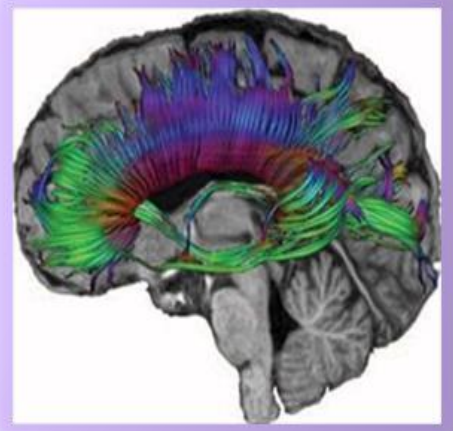
A-3: **Actual Ability to Assess...Access...Affect**
To What Effect(s) and Ends?

Neuroimaging

- PET
- CT
- MR
- fMR
- DTI
- MEG/qEEG



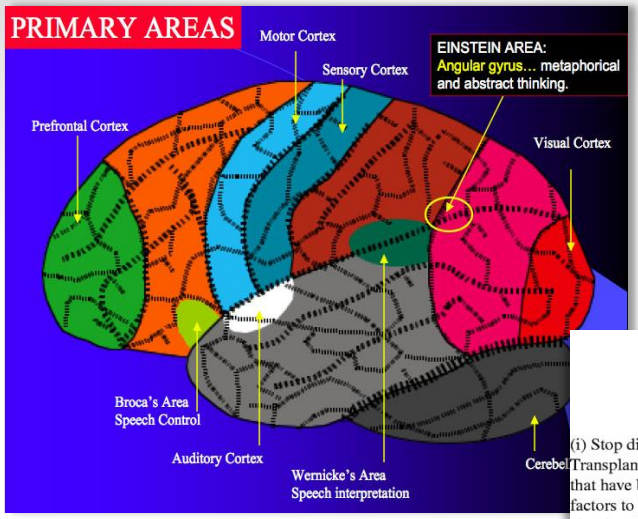


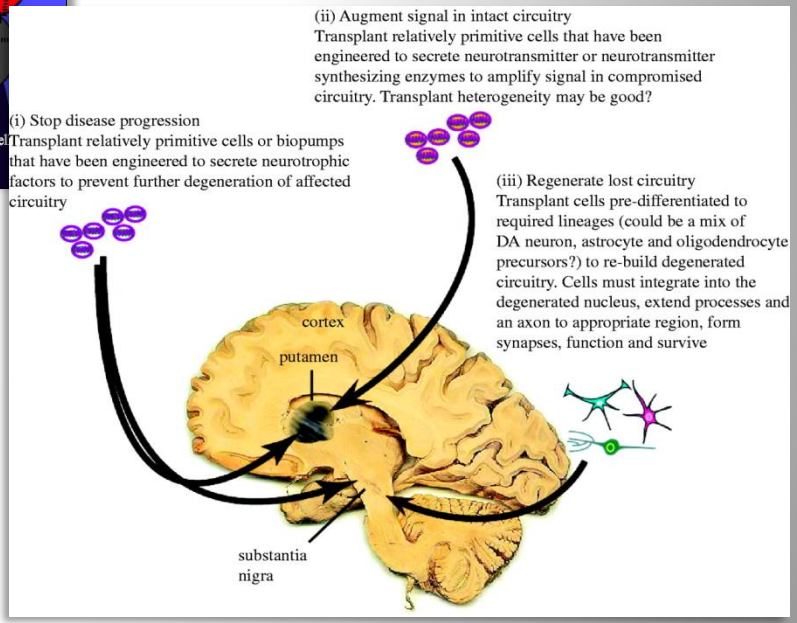


Can we Scan the Brain to Depict Consciousness and/or "Read" Minds?

Neurogenetics

- Genotyping
- Phenotyping
- Proteomics
- Genetic Intervention(s)





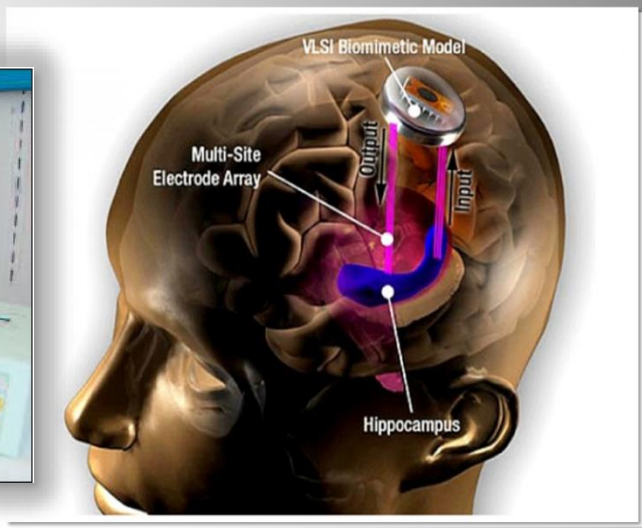
Can we "Predict" or "Create" Present and Future "Selves"?

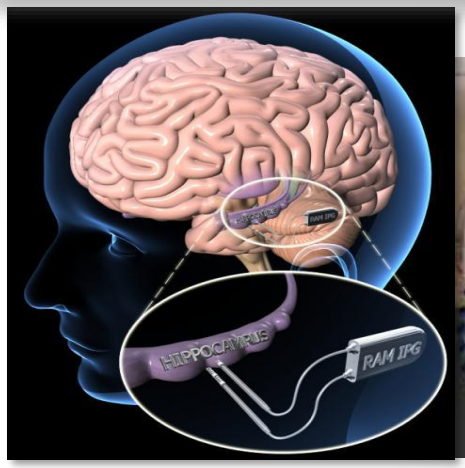
New Drugs

- Pain
- Cognition
- Emotion
- Morality

Brain-Machine Interfaces

- Transcranial stimulation
- Indwelling devices
  - Brain implants
  - Micropumps
- Tissue transplants
- Genografts
- Brain-computer interfacing
  - Neurofeedback

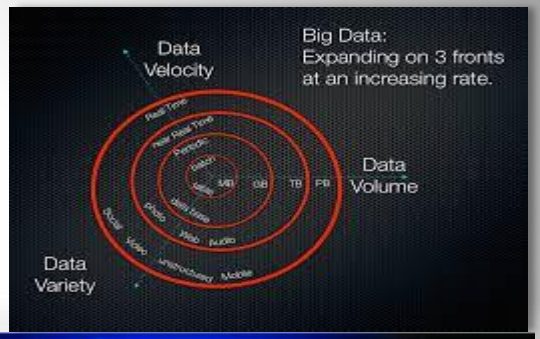




Can we "Abolish" Pain/ Sadness/ Suffering and Expand Cognitive, Emotional and/or Moral Capability?

Big Data Approaches

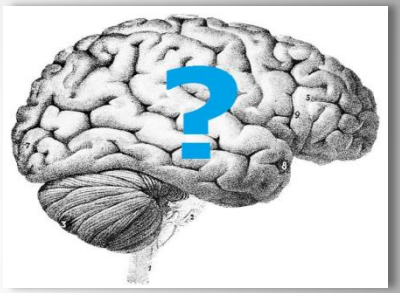
- Maximize storage and retrieval
- Parallel computing
- Scalable, customizable
- Accessible and sharable



Neuroethico-legal Issues & Risks

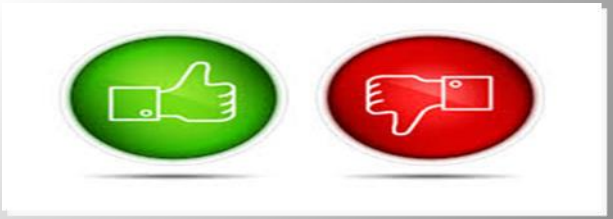
Technology-focal

- Unknowns of frontier science/technology
- Capabilities, limitations
- Validity, viability of use
- Runaway and Wexelblatt effects



Social

- Inviolability of “mind”/“cognitive liberty”
- Autonomy: Protection vs privacy
- Awareness, understanding, consent
- Treatment/protection/enhancement
- Norms, pluralization, diversity
- Justice: Provision/access



Dual- and Direct Military, Intelligence and Warfare Use of Neuroscience and Neurotechnology

Enter...Neuroethics

1. **"The neuroscience of ethics" (sic.)**

Or the study of the neural basis of human ecology, morality and ethics ("neuro-ecology as neuromorality")

2. **"The ethics of neuroscience"**

The ethical issues, questions and problems that arise in and from neuroscientific research and its applications (in medicine, public use, military, etc.)

Arguably, you cannot (or SHOULD NOT) do (1) without first and subsequently doing (2)...

Neuroethics - Preparatory not just Proscriptive

SCIENTIFICALLY

FOCAL

FACTUAL

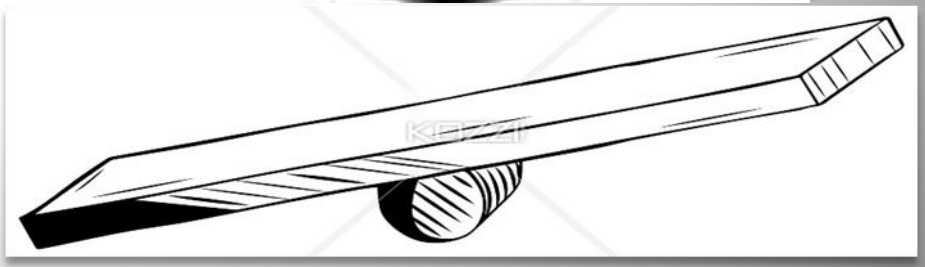
FORWARD LOOKING

SOCIALLY

SENSITIVE

RESPONSIVE

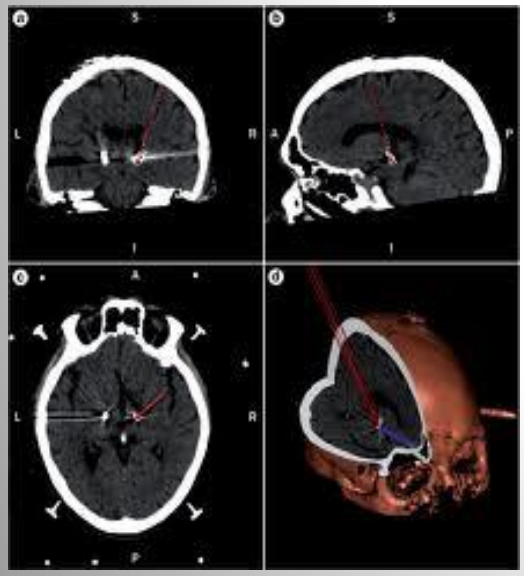
APPLICABLE



Prudential Neuroethical Questions

Given what *can* be done, how do we decide upon what *should* be done?

...and *can* it be done?



Putting Neuroethics to Work

Potentiality--------

Possibility--------

Probability-------

NeuroS/T Superspeedway

- Multiple lanes
- Multiple entries
- Rapid pace
- Competitive
- Big Prizes
- Not without risks...

Approaching the Issues

Stake-/Shareholder Groups

- Researchers and research institutions
- Health care professionals
- Business/ manufacturers
- Patients/ consumers
- Civil society and publics
- Funders
- Payers
- Policy makers
- Regulatory bodies

Frameworks for Address

- Anticipatory governance
- RRI (responsible research and innovation)
- Human rights
- Open science/ open innovation
- Innovation foresight
- Neuroethics
- Neurolaw

ON-RAMP

Operational N*euroethical* R*isk* A*ssessment and* M*itigation* P*aradigm*

<u>6-R Approach</u>

- ***Responsibility***
- ***Realistic Assessment*: of the neurotechnology**
- ***Research*: evaluating use/effects-in-practice**
- ***Responsiveness:* to burdens and deleterious effects**
- ***Revisions:* in technology and marketing**
- ***Regulation*: insure rigor in development and claims**

Poses key questions

Framed within defined parameters

Preparatory Neuroethics Paradigm

Informed by...

6-W Questions:

- ***What*** **neuroS/T are available for current use?**
- ***Why*** **is neuroS/T considered or advocated for use?**
- ***Who*** **will receive neuroS/T?**
- ***When*** **will neuroS/T be considered (algorithm/protocol)?**
- ***Where*** **will neuroS/T be administered (e.g.-hospital; clinic, school; worksite; home)?**
- ***Which*** **mechanisms will be in place for ongoing provision of services/resources?**

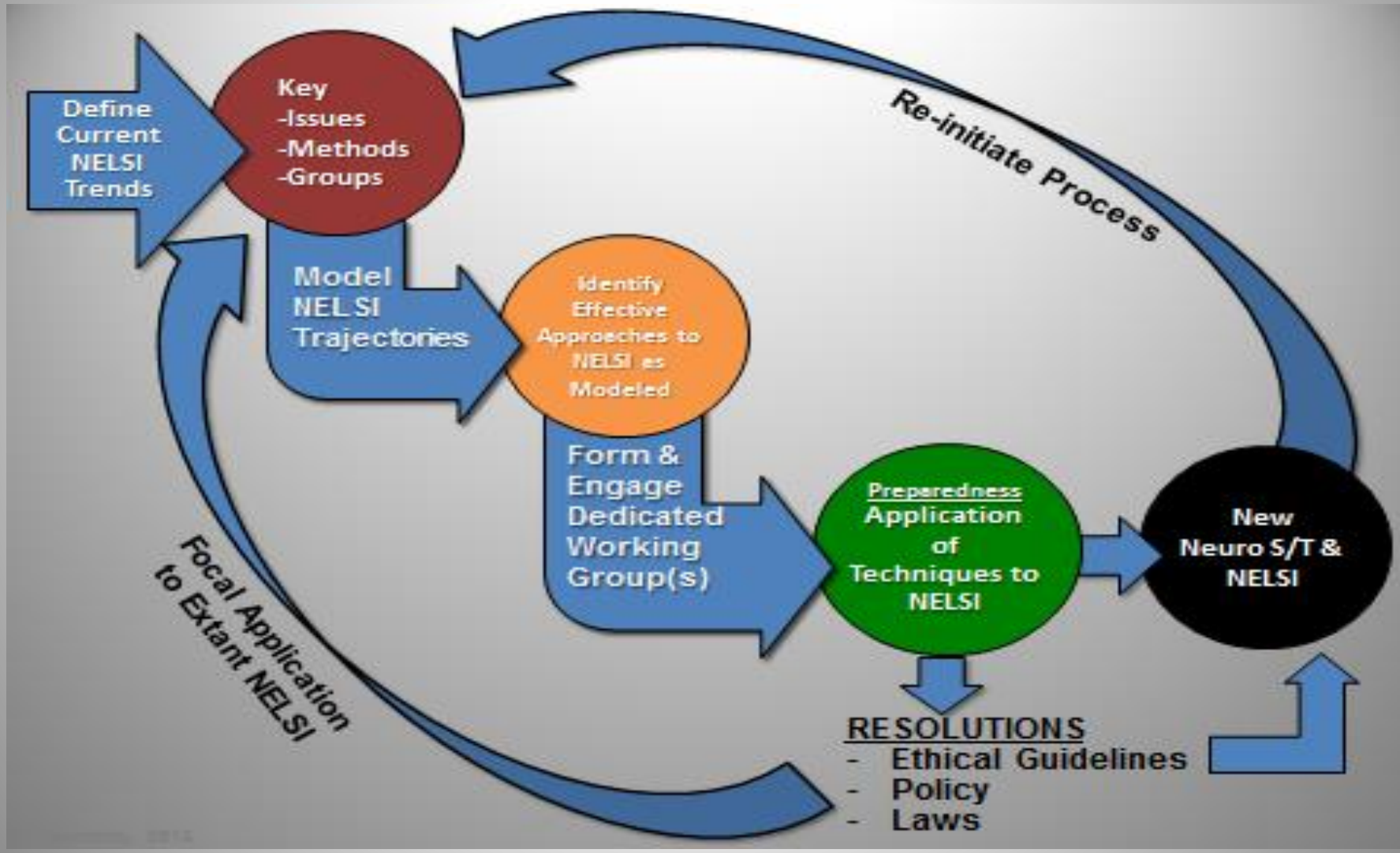
Preparatory Neuroethics Paradigm

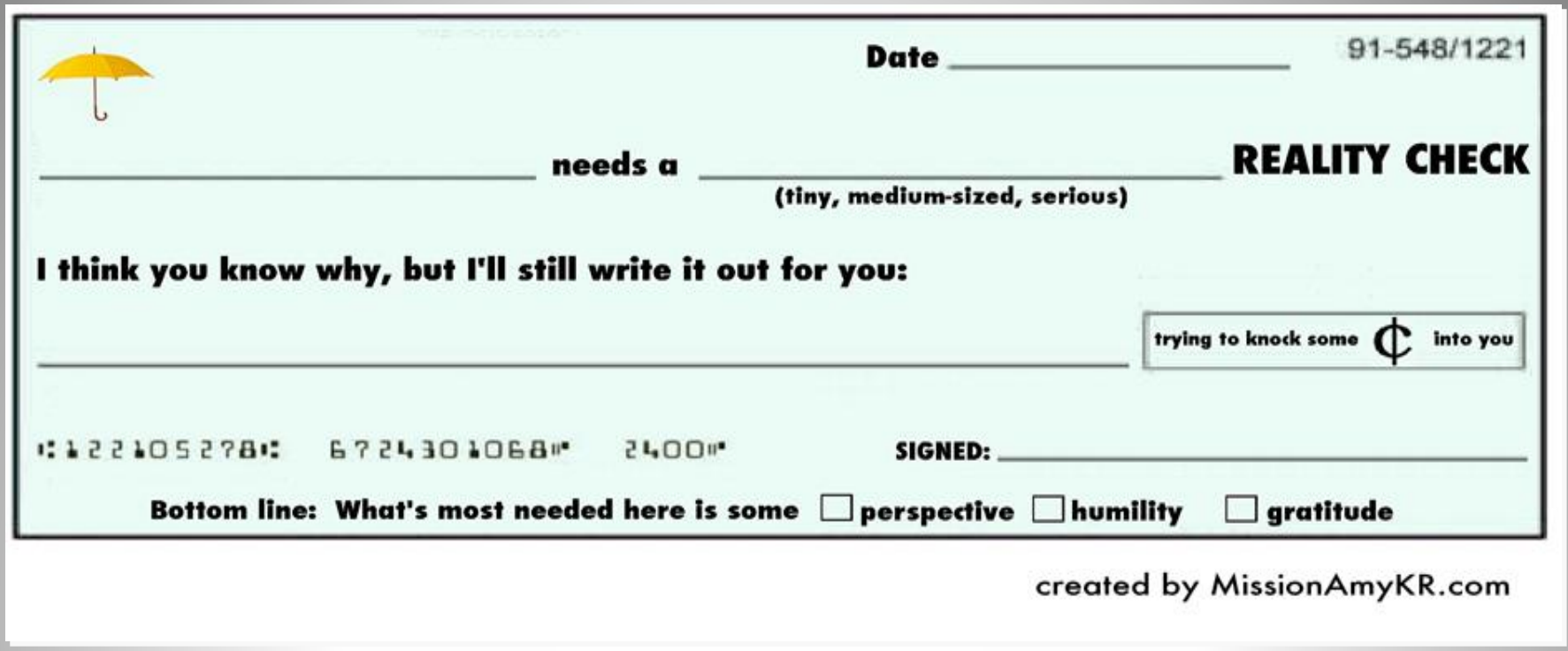
Framed by...

<u>6-C Considerations</u>:

- ***Capacities*** **and limitations of the neuroS/T**
- ***Consequences*** **incurred by neuroS/T on recipients, families, and society in the short, intermediate, and long-term**
- ***Character*** **of the research and recipient (e. g, patterns of cognition, emotion, and behavior) affected by neuroS/T**
- ***Contexts*** **of need and value that influence use of neuroS/T**
- ***Continuity*** **of research and clinical care**
- ***Consent*** **through provision most information possible**

Paradigm in Practice





Audits

1. NeuroS/T
2. Neuroethics
3. Medico-social Views/Expectations of Both

Neuroscience-Neuroethics-Policy Approach

No new neuroscience without neuroethics...

(...and no neuroethics w/o neuroscience!)

No neuroethics without informing regulatory policy

A Work in Progress…

Neuroscience, Neurotechnology and Neuroethics

With increasing knowledge comes great power…

…With great power comes great responsibility

The Ongoing Work of Neuroethics…

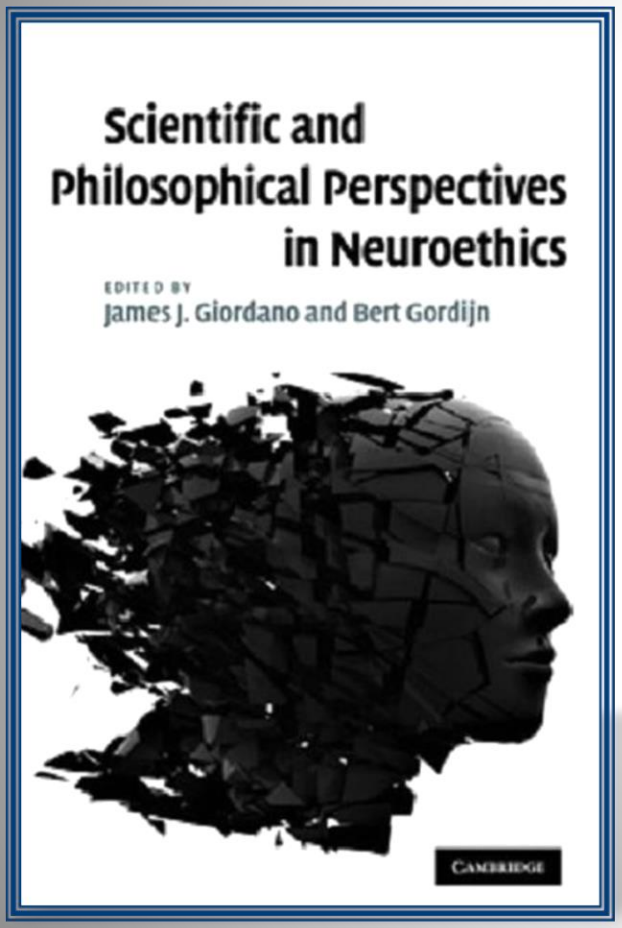
Reflection, insight and moral engagement must be the stepping stone for all future acts of inquiry, invention and intervention…

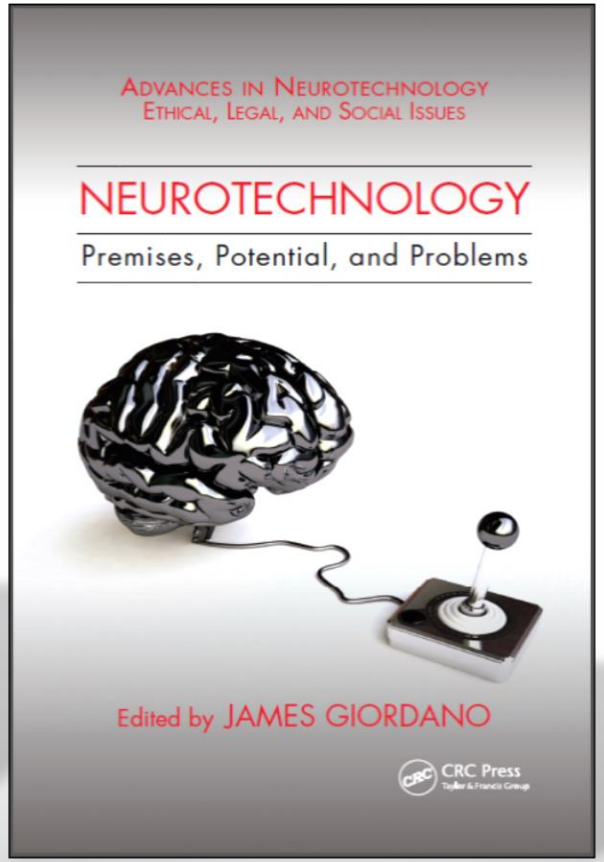
“*Measure twice, cut once*”

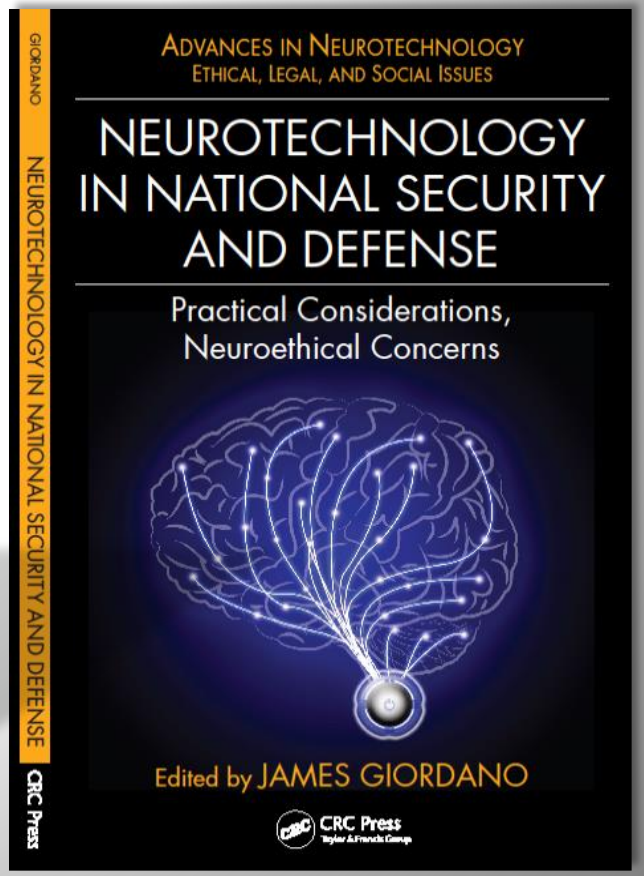
…for all too often,

there is no turning back.

Read More About It...







Selected Readings

- **Palchik G, Chen C, Giordano J. Monkey business? Development, influence and ethics of potentially dual-use brain science on the world stage. *Neuroethics,* 10:1-4 (2017)**

- **Giordano J. Toward an operational neuroethical risk analysis and mitigation paradigm for emerging neuroscience and technology (neuroS/T). *Exp Neurol* 2(3): (2016)**

- **Giordano J. A preparatory neuroethical approach to assessing developments in neurotechnology. *AMA J Ethics* 17(1): 56-61 (2015).**

- **Giordano J, Shook JR. Minding brain science in medicine: On the need for neuroethical engagement for guidance of neuroscience in clinical contexts. *Ethics Biol Engineer Med* 6(1-2): 37-42 (2015).**

- **Shook JR, Giordano J. A principled, cosmopolitan neuroethics: Considerations for international relevance. *Phil Ethics Humanities in Med* 9 (1); (2014).**

- **Giordano J. The human prospect(s) of neuroscience and neurotechnology: Domains of influence and the necessity – and questions – of neuroethics. *Human Prospect* 4(1): 1-18 (2014).**

Contact

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