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

James Giordano PhD
Departments of Neurology and Biochemistry
Neuroethics Studies Program, Pellegrino Center for Clinical Bioethics
Georgetown University Medical Center
Washington, DC, USA
and
EU-Human Brain Project
SP-12
Uppsala University, Sweden
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 \textit{with} the information and capability we have?

What do we do \textit{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

- 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

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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?

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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
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 Neuroethical Risk Assessment and Mitigation Paradigm

6-R Approach

- 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...
6-C Considerations:

• *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


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

Contact

Prof. James Giordano PhD
james.giordano@georgetown.edu