The ethics of noninvasive brain stimulation for cognitive enhancement
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Introduction

- Cognitive enhancement: enhancing the cognition of healthy individuals using methodologies originally developed for helping patients.
- Increasingly widespread use of cognitive enhancement has led to the emergence of a new and controversial field. (Cosmetic Neurology).
- Below, we consider the ethical dilemmas surrounding noninvasive brain stimulation (NIBS), a set of methodologies that have shown promise for cognitive enhancement.

NIBS Methodologies

- **Transcranial Magnetic Stimulation (TMS):**
  - Electricity passes through a copper coil, generating a magnetic field, which induces electric currents in cortex, which in turn leads to action potentials.
- **Transcranial Direct Current Stimulation (tDCS):**
  - Small electric currents (1-2mV) pass through an electrode (anode), about one half this current reaches cortex, modulating the resting membrane potentials of neurons, and passes out through a different electrode (cathode).

Examples of Cognitive Enhancement

- **Enhancing Processing Abilities:** improving memory, linguistic processing, learning abilities, information processing, etc.
- **Enhancing Social Cognition:** modulating an individual’s understanding and relationship to others, especially related to concepts of social norms and rules.

Variations:

- Spatial Resolution: 0.5mm

Transcranial Magnetic Stimulation (TMS)

- Blue lines, Electrical current lines; Red lines, Magnetic Field Lines

Transcranial Direct Current Stimulation (tDCS)

- Blue electrode, Cathode; Red electrode, Anode; Yellow lines, direction of electric current.

Spatial Resolution: 0.5mm

Electrodes were removed and subjects began the RAT.

Stimuli and Procedure

- Letters combined. The primary RAT dependent variable measured by the SD of judgments within a condition across participants.
- There was also no significant order effect on reaction times was a belief by outcome.
- Variations:
  - Stimulus and Procedure
  - Spatial Resolution: 0.5mm

Results

- Mean number and standard deviation of remote associates for anodal vs. sham condition after 30 minutes of stimulation.
- Significant increase in performance due to anodal tDCS stimulation compared to cathodal and sham.

Suggests: NIBS can be used to enhance connections in semantic networks.

Results and Discussion

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Suggests: NIBS can be used to enhance connections in semantic networks.

Main Question: What hardships are important for forming a human identity?
- Are there areas that humans have so fundamental that modulating them would change identity?
- Would long term mood modulation with NIBS be beneficial or detrimental to character? Are there certain hardships that humans need to face?

Main Question: Could someone be implicitly or explicitly coerced to undergo brain stimulation?
- Explicit coercion: punitive (criminal), investigatory (i.e. detection).
- Implicit coercion: to remain competitive (workforce, education, etc.). Evidence suggests individuals already do this with pharmacological enhancements.

References