Do-it-yourself and regulatory aspects of transcranial stimulation

Anna Wexler

Introduction to tES in Neuropsychiatric Research
June 27, 2019

TALK OUTLINE

Do-it-yourself and direct-to-consumer tDCS

Who are home users, what devices do they use, how and why do they stimulate, and do they find tDCS effective?

Regulation of tES devices in the US

FDA medical device law & tDCS devices
Academic journal publications about tDCS by year, 2000-2018

*Based on pubmed title search for tDCS or “transcranial direct current stimulation” conducted on June 1, 2019

Rise of DIY tDCS

DIY tDCS

Still Zapping My Brain. DIY tDCS Volume Two.

Frequently asked questions | tDCS device comparison table.

- PSA: Sticky electrodes and skin burns
- 1 year up to 1 month ago: Daytime
- 1 year up to 6 months ago: Weekdays
- 6 months up to 1 year: Weekends
- 1 year up to 2 years: Summers
- 2 years or more: Winters
- Is 2 sessions in the morning and one in the evening considered as safe?
- User: tDCS
- User: tDCS
- Current density.
Do-it-Yourself Device

Repurpose an iontophoresis device
Current source/tDCS device

Super Specific Devices

Caputron Medical

tDCS Devices and “Device Kits”

Brain Stimulator

tDCS-Kit

PriorMind

Apex Type A

Cognitive Kit
Wearable Devices

**Halo Neuroscience**

![Halo Neuroscience headphones](image)

**PlatoWork brain stimulator**

The world's first headset for boosting cognition: improve your memory, focus and creativity!

**Project: PlatoWork Neurostimulation**

Copenhagen, Denmark

$413,342 USD total funds raised
366% funded on May 4, 2019

**Medication-free depression treatment**

![Medication-free depression treatment](image)
Blurred Boundaries Between DIY & DTC devices

Do-it-yourself (DIY)  Direct-to-consumer (DTC)

Transcranial devices are not playthings

Controlled investigation of transcranial direct-current stimulation (tDCS) for treating neuropsychiatric disorders or for neurorehabilitation should not be confused with improvised devices or practices that apply electricity to the brain without reference to established protocols (see Nature, 498, 571–572, 2013). Uninformed technologies and applications must not be allowed to distort the long-term validation of tDCS.

Warning over electrical brain stimulation

Neuroscience Researchers Caution Public About Hidden Risks of Self-administered Brain Stimulation

Warning over experimental brain boost

Thus, the IFCN warns against the use of DIY devices and methods unless they have shown both efficacy and safety.
Researchers | Home users
---|---
Use tDCS in laboratory | Use tDCS at home
Apply tDCS to subjects | Apply tDCS to themselves
Primary purpose: research | Primary purpose: self-improvement
Controlled, regulated environment | Uncontrolled environment

**Studying home users of tDCS**

**Ethnography** of home users *(Wexler 2016)*

- Analysis of DIY tDCS websites, forums and blogs
- Semi-structured interviews with home users

**Survey** of consumers of tDCS devices *(Wexler 2018)*

- 7 companies agreed to participate on the condition of anonymity; emails sent to companies’ customer lists with link to online survey
- Quantitative and open-ended qualitative questions about tDCS device(s), use practices, beliefs, attitudes, and demographics
Who are home users?

- Wealthy
- Highly educated (77.9% have a college degree or higher; 36.5% Master's or higher)
- Politically liberal (70.5%)
- Early adopters of technology (63.7%)
- Read articles about science frequently or very frequently (82.3%)
- Never or rarely attend religious services (77.9%)
- Nearly half have used dietary supplements or non-prescription drugs to improve cognition

Wexler (2018)
Enhancement: Have you self-administered tDCS to improve "normal" abilities?

Treatment: Have you self-administered tDCS to treat a medical/psychological disease or condition?

Restoration: Have you self-administered tDCS to restore diminished abilities (for example, to counteract the effects of aging)?

Table 4. Detailed usage indications for treaters, enhancers, and restorers*

<table>
<thead>
<tr>
<th></th>
<th>n</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Treatment</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Depression</td>
<td>97</td>
<td>74.0%</td>
</tr>
<tr>
<td>Anxiety</td>
<td>55</td>
<td>42.0%</td>
</tr>
<tr>
<td>ADD/ADHD</td>
<td>35</td>
<td>26.7%</td>
</tr>
<tr>
<td>Chronic pain</td>
<td>12</td>
<td>9.2%</td>
</tr>
<tr>
<td>Bipolar disorder</td>
<td>7</td>
<td>5.3%</td>
</tr>
<tr>
<td>Migraine</td>
<td>7</td>
<td>5.3%</td>
</tr>
<tr>
<td>Tinnitus</td>
<td>6</td>
<td>4.6%</td>
</tr>
<tr>
<td>Addiction</td>
<td>5</td>
<td>3.8%</td>
</tr>
<tr>
<td><strong>Enhancement</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Focus/concentration</td>
<td>100</td>
<td>42.2%</td>
</tr>
<tr>
<td>Memory</td>
<td>61</td>
<td>25.7%</td>
</tr>
<tr>
<td>Learning</td>
<td>57</td>
<td>24.1%</td>
</tr>
<tr>
<td>General Enhancement</td>
<td>56</td>
<td>23.6%</td>
</tr>
<tr>
<td>Mood/emotion</td>
<td>26</td>
<td>11.0%</td>
</tr>
<tr>
<td>Physical abilities</td>
<td>25</td>
<td>10.5%</td>
</tr>
<tr>
<td>Speed/reaction time</td>
<td>23</td>
<td>9.7%</td>
</tr>
<tr>
<td>Creativity</td>
<td>14</td>
<td>5.9%</td>
</tr>
<tr>
<td><strong>Restoration</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Memory</td>
<td>31</td>
<td>38.3%</td>
</tr>
<tr>
<td>Focus/concentration</td>
<td>21</td>
<td>25.9%</td>
</tr>
<tr>
<td>General enhancement</td>
<td>19</td>
<td>23.5%</td>
</tr>
<tr>
<td>Problem solving</td>
<td>12</td>
<td>14.8%</td>
</tr>
<tr>
<td>Mood/emotion</td>
<td>9</td>
<td>11.1%</td>
</tr>
<tr>
<td>Other</td>
<td>8</td>
<td>9.9%</td>
</tr>
<tr>
<td>Learning</td>
<td>7</td>
<td>8.6%</td>
</tr>
<tr>
<td>Speed/reaction time</td>
<td>4</td>
<td>4.9%</td>
</tr>
<tr>
<td>Physical abilities</td>
<td>4</td>
<td>4.9%</td>
</tr>
</tbody>
</table>

*Participants who answered affirmatively to having used tDCS for either treatment, enhancement, or restoration were asked to provide follow-up information, by selecting from a list of diseases/conditions (for treatment) or elaborating via free-form text (for restoration/enhancement); the latter responses were coded thematically.
To what extent did you feel that your use of tDCS was successful?

![Bar chart showing responses to the question](chart.png)

Wexler (2018)

### Usage Characteristics

- Home users mostly adhere to established scientific protocols (e.g., current level & session duration) but depart regarding number of stimulation sessions
- When using non-pre-set devices, look to scientific literature and placement websites
- 35% of users quit using tDCS, approximately half due to lack of efficacy

Wexler (2018)
**Did you experience unwanted side effects from tDCS? If yes, please describe.**

<table>
<thead>
<tr>
<th>Condition</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>No</td>
<td>38.0%</td>
</tr>
<tr>
<td>Skin Irritation</td>
<td>35.4%</td>
</tr>
<tr>
<td>&quot;Skin burn&quot; or &quot;burning&quot; sensation</td>
<td>16.9%</td>
</tr>
<tr>
<td>Headache</td>
<td>10.1%</td>
</tr>
<tr>
<td>Flash of light (phosphenes)</td>
<td>8.4%</td>
</tr>
<tr>
<td>Dizziness</td>
<td>1.9%</td>
</tr>
<tr>
<td>Metallic Taste</td>
<td>1.5%</td>
</tr>
</tbody>
</table>

*10 reports of serious skin burn*  

**PRACTICES OF DIY BRAIN STIMULATION**

- **Recognize** that home users are utilizing tDCS both for treatment and enhancement
- **Be aware** that an unintended “second audience” is utilizing published scientific research
- **Be prepared** for individuals to approach you for guidance
- Warning home users/DIYers of risks (Wurzman et al. 2016)
**An Open Letter Concerning Do-It-Yourself Users of Transcranial Direct Current Stimulation**

Wurzman et al. (2016)

- Stimulation affects more of the brain than a user may think.
- Enhancement of some cognitive abilities may come at the cost of others.
- Changes in brain activity (intended or not) may last longer than a user may think.
- Small differences in tDCS parameters can have a big effect.
- tDCS effects are highly variable across different people.

---

**Regulation of direct-to-consumer tDCS Devices**

Are consumer tDCS devices medical devices?
Food & Drugs Act (1906)
- Prohibited misbranded & adulterated food and drugs

Federal Food Drug & Cosmetic Act (1938)
- Granted FDA limited jurisdiction over medical devices

Medical Device Amendments (1976)
- Device manufacturers required to notify FDA of medical device prior to marketing
**RISK-BASED CLASSIFICATION FRAMEWORK**

<table>
<thead>
<tr>
<th>Class I</th>
<th>Class II</th>
<th>Class III</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low risk</td>
<td>Moderate risk</td>
<td>High risk</td>
</tr>
</tbody>
</table>

| Most products exempt from pre-market notification | Pre-market notification (PMN) required via 510(k). Devices are “cleared.” | Pre-market approval (PMA)—must demonstrate safety & efficacy |

**FDA APPROVED/CLEARED STIMULATION DEVICES**

<table>
<thead>
<tr>
<th>Class I</th>
<th>Class II</th>
<th>Class III</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low risk</td>
<td>Moderate risk</td>
<td>High risk</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>TENS (pain/headache)</th>
<th>rTMS (treatment-resistant MDD)</th>
<th>DBS (Parkinson’s related)</th>
</tr>
</thead>
<tbody>
<tr>
<td>TMS (headache)</td>
<td>tvNS (cluster headache)</td>
<td>VNS (epilepsy-related)</td>
</tr>
<tr>
<td>ECT (catatonia + depression)$^1$</td>
<td></td>
<td>CES (depression, insomnia$^2$ &amp; anxiety$^2$)</td>
</tr>
<tr>
<td>ECT (all other indications)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

---

1. Severe major depressive episode associated with major depressive disorder or bipolar disorder
2. Proposed reclassifying in 2016 to Class II
According to Section 201(h) of the Food, Drug & Cosmetic (FD&C) Act, a medical device is:

- an instrument, apparatus, implement, machine, contrivance, implant, in vitro reagent, or other similar or related article, including a component part, or accessory which is:
  - recognized in the official National Formulary, or the United States Pharmacopoeia, or any supplement to them,
  - intended for use in the diagnosis of disease or other conditions, or in the cure, mitigation, treatment, or prevention of disease, in man or other animals, or
  - intended to affect the structure or any function of the body of man or other animals, and which does not achieve its primary intended purposes through chemical action within or on the body of man or other animals and which is not dependent upon being metabolized for the achievement of any of its primary intended purposes.
IMPORTANT OF INTENDED USE

Drug vs. Cosmetic

"reduces wrinkles"

sunscreen lotion

"reduces the appearances of wrinkles"

suntan lotion

Direct-to-consumer tDSC Devices

Power Your Mind!

tDSC Provides a Learning Boost

increases your attention span and stimulates your

recreational, improve math skills, language abilities,

creativity, and visual association.

RECHARGE YOUR BRAIN

tDSC allows you to unlock your brain's true potential!

Reducing Depression

Reducing pain

tDSC for Medical Use

tDSC has been widely applied to treat Depression,

also in Chronic Pain, Ambyloopia, Alzheimer’s disease,

Migraine, Parkinsonism, Tinnitus, Stroke and etc.

Finally, there is drug free (TRY) method to increase concentration as well as relief for Depression, Anxiety and Migraines.
DEFINITION OF A MEDICAL DEVICE

According to Section 201(h) of the Food, Drug & Cosmetic (FD&C) Act, a medical device is:

- an instrument, apparatus, implement, machine, contrivance, implant, in vitro reagent, or other similar or related article, including a component part, or accessory which is:
  - recognized in the official National Formulary, or the United States Pharmacopoeia, or any supplement to them,
  - intended for use in the diagnosis of disease or other conditions, or in the cure, mitigation, treatment, or prevention of disease, in man or other animals, or
  - intended to affect the structure or any function of the body of man or other animals, and which does not achieve its primary intended purposes through chemical action within or on the body of man or other animals and which is not dependent upon being metabolized for the achievement of any of its primary intended purposes.

intended to affect the structure or any function of the body of man or other animals...

Three wrinkle-remover cream cases:
- United States v. An Article … Sudden Change, 409 F.2d 734 (2d Cir. 1969)
- United States v. An Article … Line Away, 415 F.2d 369 (3d Cir. 1969)

"intended to affect the structure or function of the body" [in some medical or drug-type fashion]
FDA AND PUBLIC HEALTH RISK

Various cases have shown that the courts are often willing to allow the FDA significant leeway

21 USC § 393: “promote the public health... protect the public health”

<table>
<thead>
<tr>
<th>General Wellness: Policy for Low Risk Devices</th>
</tr>
</thead>
<tbody>
<tr>
<td>Draft Guidance for Industry and Food and Drug Administration Staff</td>
</tr>
</tbody>
</table>

A **general wellness product** is one that makes claims related to “maintaining or encouraging a general state of health” without references to diseases or conditions

Examples of acceptable wellness claims are those relating to:

- “mental acuity”
- “concentration”
- “problem-solving”
- “relaxation and stress management”
general wellness products presenting a low risk to safety will *not* be regulated as medical devices by the FDA

A product is *not* a low-risk device if “it involves an intervention or technology that may pose a risk to a user’s safety if device controls are not applied.”

Are consumer non-invasive brain stimulation device *low-risk* devices?

The following are examples of products that would *not* be considered “low risk” as described in this guidance:

- A neurostimulation product that claims to improve memory, due to the risks to a user’s safety from electrical stimulation.
CONSUMER PRODUCT SAFETY COMMISSION

(1) to protect the public against unreasonable risks of injury associated with consumer products;
(2) to assist consumers in evaluating the comparative safety of consumer products;
(3) to develop uniform safety standards for consumer products and to minimize conflicting State and local regulations; and
(4) to promote research and investigation into the causes and prevention of product-related deaths, illnesses, and injuries.

What is a consumer product?

any article, or component part thereof, produced or distributed (i) for sale to a consumer for use in or around a permanent or temporary household or residence, a school, in recreation, or otherwise, or (ii) for the personal use, consumption or enjoyment of a consumer in or around a permanent or temporary household or residence, a school, in recreation, or otherwise;
Section 5 of the FTC Act prohibits “unfair or deceptive acts or practices” in commerce.

STATE AUTHORITIES

CDPH Warns Consumers Not to Use TDCS Home Device Kit

Date: 10/08/2013
Number: 13-053
Contact: Anita Gore, health bourbeau (916) 440-7259

SACRAMENTO

The California Department of Public Health (CDPH) today warned consumers not to use the unapproved medical device sold on the Internet as a TDCS (Transdermal Direct Current Stimulation) Home Device Kit.

TDCS Device Kit, Inc. of Petaluma, Calif., is voluntarily recalling the TDCS Home Device Kits because the product has not been federally approved to market in the United States, and has not been determined to be safe and effective for the intended use. During a recent inspection, CDPH determined that the devices had not been manufactured in compliance with good manufacturing practices for medical devices. Also, the devices were found to be labeled without adequate directions for use and without adequate warnings against use that may be dangerous to health.

Use of the device could pose a health risk including, but not limited to: epileptic seizures, cardiac arrhythmias, cardiac arrest, optic and ocul nerve injuries, skin irritation, headaches, blurred vision, and dizziness. No illnesses or injuries have been reported at this time.

Recalled TDCS Device Kits were manufactured and distributed worldwide from November 2012 through April 2013. The devices have no identifying control numbers (e.g., lot codes, serial numbers, or production dates) printed either on the packaging, or the units themselves, but would have been received by mail from TDCS Device Kit, Inc.
TAKE-AWAY POINTS

- FDA definition of a medical device is based on “intended use” not mechanism of action
- Most recent actions demonstrate that FDA is monitoring the sphere and does not view tDCS as completely low-risk
- Unclear whether cognitive enhancement devices marketed for “wellness” fit the structure/function clause of FDA definition of a medical device
- Even absent FDA regulations, other regulatory agencies might play a role
Direct-to-consumer neurotechnology

- the set of products (devices, software, applications) that are marketed to modulate or affect brain function
- sold directly to consumers (i.e., bypassing the physician)
- appeal to the fruits of brain and cognitive science
What should we do?

- Independent working group
  - Evaluate the main domains of neurotechnology & provide appraisals of potential harm and probable efficacy
  - Disseminate information to key consumer groups (e.g., AARP), media outlets, etc.
  - Identify areas for future research
  - Serve as a clearinghouse for regulatory agencies, third-party organizations that monitor advertising claims, industry, funding agencies

Thank you!


awex@upenn.edu