Addiction Neuroethics: An exploration of the social and ethical issues of using stimulation based neurotechnology to treat drug addiction

Claudia Barned, PhD – Institut de Recherches Cliniques de Montreal and McGill University

OUTLINE

Addiction & Treatment Approaches

• Pharmacological Approaches
• Behavioural Therapy
• Neurotechnology

Neuroscience Developments

Addiction Neuroethics

DBS & tDCS - Ethical & Social Issues

Conclusions & Implications
Modern neuroscience has given rise to a range of possible treatments for addiction. Recent developments promise to improve the lived experience of those with an addiction by helping in abstinence and treatment efforts.

- Over the years we have seen a drastic development in the types of neurotechnology marketed for the treatment of addiction. DBS and tDCS have been proposed as emerging neurotechnology to treat addiction.

- Risks and benefits?
  - Potential misuse or harm that might arise in particular situations?
Addiction Neuroethics

- An emerging field that "examines the neuroethical challenges raised by neuroscience research on addiction, its potential applications in the treatment and prevention of addiction and the formulation of social policies toward drug use."
  
  [Carter, Hall & Illes, 2012]

Neurotechnology targeting addiction

Deep Brain Stimulation

- Neurosurgical intervention originally developed to treat intractable cases of neurological movement disorders (such as Parkinson's disease).
  - Persons with PD who have failed to respond or who no longer respond to pharmacological treatments.
  - OCD, depression and Tourette's syndrome
  - Trialed as a treatment for addiction [Krack et al., 2010]

- Involves the insertion of microelectrodes into specific regions of the brain in order to modulate neural activity via electrical current [Carter et al., 2009].

- The premise is that DBS resolves an electrical imbalance at the level of the cortico-basal ganglia-thalamocortical loop by inactivating the target area [Sakai et al, 2006].
In what context has DBS been proposed to treat addiction?

Case studies of DBS use for addiction

Woman successfully treated for agoraphobia by bilateral DBS of the Nacc (which also ameliorated her comorbid alcohol dependence) (Kuhn et al., 2007).

3 of 10 people were treated for Tourette’s syndrome, OCD or anxiety by means of DBS of the Nacc; these three reported smoking cessation (Kuhn et al., 2009).

Treatment – refractory OCD quit smoking after receiving DBS of the Nacc [however these changes took place 10 months after her DBS treatment]

Research Report

Observations on Unaided Smoking Cessation after Deep Brain Stimulation of the Nucleus Accumbens

Kuhn J.1, Bauer R.1, Pohl S.2, Lenartz D.3, Huf M.3, Kim E.M.4, Klosterkotter J.3, Sturm V.1

Aims: We explore whether clinical research on deep brain stimulation (DBS) of the nucleus accumbens (NAc) to treat addiction is justified besides theoretical speculation. Methods: Since 2004, 10 patients who were also smokers were treated at the University of Cologne for Tourette’s syndrome (TS), obsessive-compulsive disorders (OCDs) or anxiety disorders (ADs) by DBS of the NAc. We assessed their smoking behavior after DBS and (in retrospect) before the Fagerström Test for Nicotine Dependence (FTND) and additional items. Results: Three male patients were able to quit smoking after DBS. They were less dependent and higher motivated compared to the rest of the sample. They were stimulated with a higher voltage. During 3-year, 3- and 6-month follow-ups, we found a higher rate of successful smoking cessation (12.5, 20 and 36%) compared to unaided smoking cessation in the general population (13, 15 and 8.7%). Conclusion: Although the results of the study are severely limited by the method of retrospective self-assessment of psychiatric patients, further research on DBS of the NAc to treat addiction seems justified. In addition to biological mediators, psychosocial factors should be assessed in further prospective studies.
Improvement in craving for alcohol after DBS

Deep Brain Stimulation Surgery for Alcohol Addiction
Juergen Vogt, A.R., Ulf Müller, Berhard Bogerts, Thomas Münte, Hans-Jochen Heinz

Results
Five patients were treated off-label with bilateral NAc DBS for severe alcohol addiction
(average follow-up 38 months). All patients experienced significant and ongoing
improvement of craving. Two patients remained completely abstinent for more than 4
years. NAc stimulation was tolerated without permanent side effects. Simultaneous
recording of local field potentials from the target area and surface electroencephalography
while patients performed neuropsychological tasks gave a hint on the pivotal role of the
NAc in processing alcohol-related cues.

Remission of alcohol dependency following deep brain stimulation of
the nucleus accumbens: valuable therapeutic implications?
Jens Kuhn, Doro Lissartz, Wolfgang Hoff, Susanne Lee, Athanasios Koutsouka, Joachim Klotzkarlotten, Volker Sturm

Abstract
Chronic consumption of alcohol represents one of the greatest health and socioeconomic problems worldwide. We report on a 34-
year-old patient with a severe anxiety disorder and secondary depression disorder who underwent bilateral deep brain stimulation (DBS) of
the nucleus accumbens successfully. Despite the absence of disease improvement in his primary disorder, we obtained a
remarkable, although not primarily intended alleviation of the patient's comorbid alcohol dependency. Our case report
demonstrates the warrantly effective treatment of alcohol dependance by means of DBS of the nucleus accumbens and may
reveal new prospects in overcoming therapy resistance in dependences in general.

Lesioning of nucleus accumbens reduces opioid addiction

Nucleus Accumbens Surgery for Addiction
Nan Li, Jing Wang, Xue-lan Wang, A. Chong-wang Cheng, Shun-nan Ge, Li Gao, He-ming Wu, He-kang Zhao,
Ning Deng, Guo-dong Gao, X. Xi

Results
The short-term outcomes were encouraging and triggered rapid application of this
treatment in China from 2003 to 2004. However, lack of long-term outcomes and
discussion eventually led to halting the surgery for addiction by the Ministry of Health of
China in November 2004 and a nationwide survey about it later. Our institute had
performed this surgery in 272 patients with severe heroin addiction. The follow-up study
showed that the 5-year nonrelapse rate was 58% and the quality of life was significantly
improved. Patients had several kinds of side effects, but the incidence rate was relatively
low. The patients gradually recovered more than 5 years after the surgery. The side effects
did not severely influence an individual’s life or work. Nationwide surgery showed that the
nonrelapse rate was 50% in the sample of 150 cases, from 1167 patients overall who
underwent stereotactic surgery in China.
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- DBS & tDCS - Ethical & Social Issues
- Conclusions & Implications

Over-simplistic & optimistic media portrayals
DBS Concerns

- Application of DBS to addiction not obvious
  - Still identifying the neural circuitry
  - Not certain of its neural and neurochemical effects
- Safety concerns
  - Infections
  - Could cause psychological, emotional & behavioural disturbances
- Not enough justification for use of DBS in addiction
  - Pharmacological and psychotherapeutic remedies exist that are not as invasive and have been proven effective
  - Doesn’t warrant such procedures when benefits are unknown and might not outweigh the harms.
  - Extremely expensive procedure ($50,000 US) with ($10,000 – ongoing maintenance every few years.

Transcranial Direct Current Stimulation (tDCS)

- tDCS is a non-invasive form of neurostimulation that delivers a low electric current via an anode and cathode placed on the scalp.

  - Electrical current penetrates the skull and modulates brain activity by:
    1. Changing the resting membrane potential of the neurons (altering the baseline level of targeted neurons).
    2. Modulating synaptic activity in a manner similar to long-term potentiation (at the anode) and long-term depression (at the cathode).

  - Salling & Martinez, 2016)

- Studies have investigated the effects of tDCS on nicotine dependence, specifically on craving and nicotine cues.
  - Results suggest that tDCS may reduce craving for nicotine (though not consistent)

  - Salling & Martinez, 2016)

  - Studies show a less consistent effect on alcohol craving
    - Mixed results – for some, tDCS was found to reduce cravings, but for others, there was no difference

Ethical & Social Concerns

- Safety and efficacy aspects
  - Compared to DBS, tDCS is reported to be extremely safe.
  - Safety risks described are mild headaches and mid burning or itching sensation under the electrodes.
  - Given the relative newness of these technologies, not much is known about the chronic long-term effects.
  - Future studies may reveal unexpected side effects that are more serious than those associated with traditional methods of addiction treatment.

Questions to Consider

- Can these technologies be accessed by the population they are designed to help?
- How cost effective are they?

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Conclusions

- Neuroscience has the potential to provide novel methods for reducing addictive behaviour and the resulting harms.
- It is important that these methods be developed and used in ways that take account of the social context in which addiction treatment is provided.
- Safety and efficacy concerns need to be validated before such technology can be released or made available on the market.