

# Neuroenhancement: Technology to Policy

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## Project Purpose

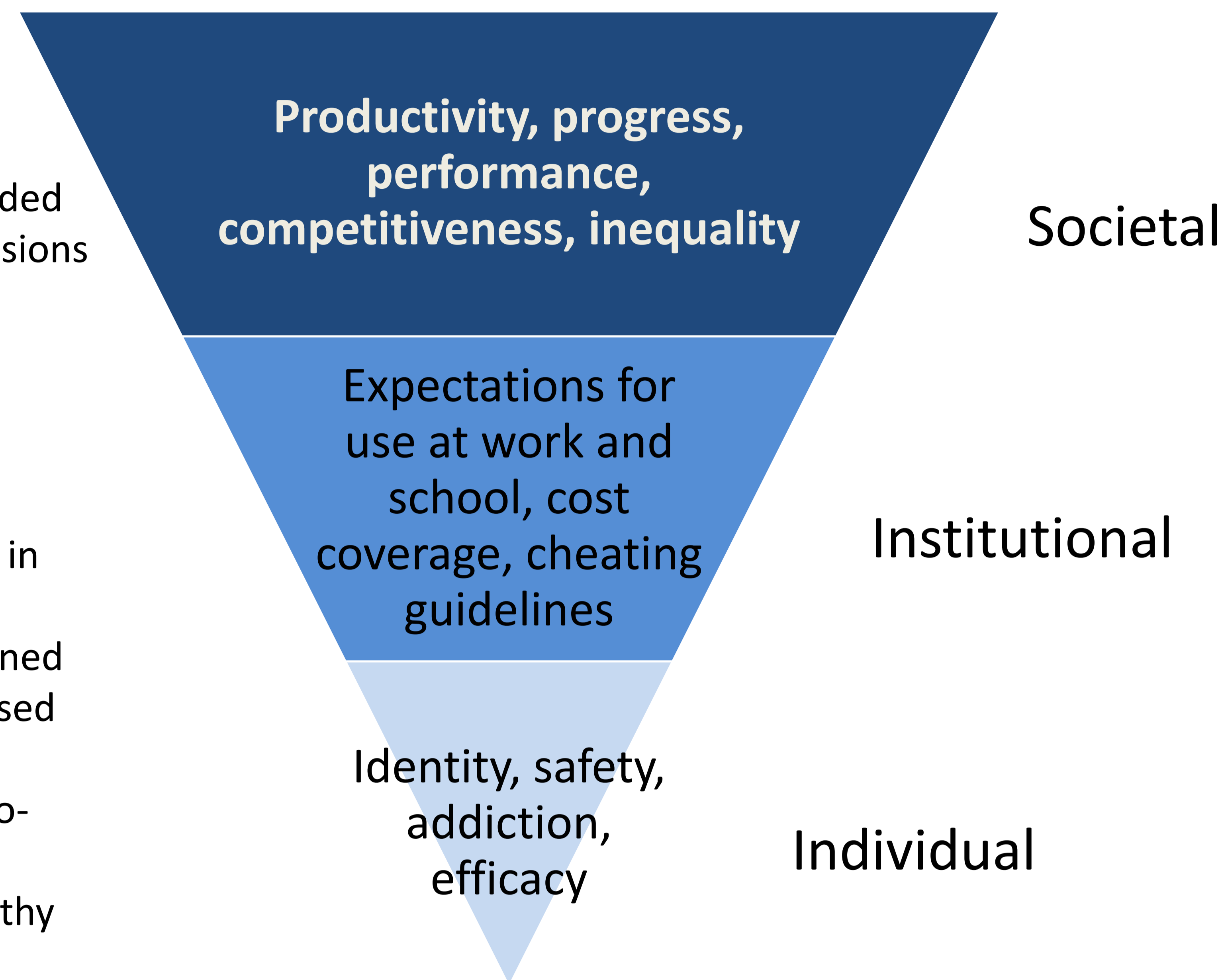
The purpose of this project was to conduct a scoping literature review pertaining to neuroenhancement of healthy individuals. The results of the review are intended to help to inform future research directions and discussions with respect to neuroenhancement.

## Introduction

We often think of health, treatment and rehabilitation in relation to achieving what is typically 'normal' for the human body (1). However, treatments that were designed for rehabilitative and restoration purposes are being used with the intention of bringing oneself *above* what is average for humans (2). Cognitive enhancement and so-called 'neuroenhancement' refer to the use of pharmaceuticals, natural products and devices by healthy individuals to improve cognitive and neuro abilities. Neuroenhancement is a recognized issue and a controversial topic within academic circles and the media (3,4).

## Methods

- Review of neuroenhancement and cognitive enhancement academic literature
- Databases: JSTOR, ScienceDirect, PubMed, EBSCO— Academic Search Complete, Web of Science and Scopus (Elsevier)
- Inclusion: Full-text English, article must address neuro/ cognitive enhancements in a non-rehabilitative fashion
- Software: For deciding which articles to use we employed Knowledge Share ver. 2.1.3 (KSv2), developed by Dean Yergens (<http://people.ucalgary.ca/~dyergens/ksv2.htm>)
- Atlas.ti 6.27 for in-depth thematic analysis



**Figure 1.** Visual representation of themes identified within the neuro and cognitive enhancement literature based on their level of impact.

Applications	# of total mentions within literature
Amphetamine	151
Adderall	26
Dexedrine	0
Nicotine	9
Modafinil	84
Caffeine	38
Methylphenidate	175
Ritalin	62
Donepezil	78
SSRI	27
Direct Brain Stimulation	0
Deep Brain Stimulation	5
Brain machine interface	0
Direct current stimulation	1
Transcranial magnetic stimulation	14
Neural Prosthetics	2
Neuroprosthetics	3
Neural Implants	2
Genetic Manipulation	2
Genetic Engineering	2

**Figure 2.** Appearance of various enhancing techniques within 61 articles discussing neuro- and cognitive enhancement.

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## Results

- 61 articles fit inclusion criteria
- Issues to be concerned about existed on three levels: individual, institutional, and societal (see figure 1)
- Focus on pharmaceuticals, mainly those developed for treating ADHD and Alzheimer's (figure 2). Little discussion on surgical interventions and devices, despite that these may be more effective than current pharmaceuticals.
- Some drugs have shown mild neuroenhancing effects on certain aspects of memory, but not enough studies have been conducted to conclude that current pharmaceuticals are or are not effective (or safe) neuroenhancements (5-7).
- However, a major issue exists within the media, where the positive effects of neuroenhancements are exaggerated and the negative effects are downplayed (4).

## Implications and Future Research

- Need for more clinical trials to determine efficacy and safety of neuroenhancements, particularly in the long term, before the discussion can proceed much further
- Need for robust statistics on the usage of certain drugs for the purposes of neuroenhancement specifically, not just non-medical use
- Greater exploration needed on public opinion regarding neuroenhancements, especially with respect to differing methods of neuroenhancement, use on children, and the impact of neuroenhancement on personal identity
- We are in the process of ascertaining the views of parents with and without children with disabilities; disability service organizations and students.

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