DRIVEN to DISTRACTION

Contemplative Neuroscience and its Implications for Addiction

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Chief of Integrative Medicine at Sierra Tucson
Mental Healthcare Costs for All Americans (1996–2006)

Total Expenditures (in billions)

<table>
<thead>
<tr>
<th>Year</th>
<th>1996</th>
<th>2002</th>
<th>2004</th>
<th>2006</th>
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<tbody>
<tr>
<td>Billions (dollars)</td>
<td>35.2</td>
<td>47.5</td>
<td>52.0</td>
<td>57.5</td>
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Number of Americans (millions)

<table>
<thead>
<tr>
<th>Year</th>
<th>1996</th>
<th>2002</th>
<th>2004</th>
<th>2006</th>
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</thead>
<tbody>
<tr>
<td>Millions (number)</td>
<td>19.3</td>
<td>31.2</td>
<td>33.8</td>
<td>36.2</td>
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Average Expenditure Per Person

<table>
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<tr>
<th>Year</th>
<th>1996</th>
<th>2002</th>
<th>2004</th>
<th>2006</th>
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<tbody>
<tr>
<td>Expenditure (dollars)</td>
<td>1,825</td>
<td>1,522</td>
<td>1,538</td>
<td>1,591</td>
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Data courtesy of AHRQ
Change in Mental Health Payments by Provider (1993 vs. 2003)

- Retail Drug
- Physicians
- Specialty Hospitals
- General Hospital, Non-Specialty Units
- Specialty Units, General Hospitals

Percent of Mental Health Expenditures

Data courtesy of SAMHSA
Antidepressants are only more effective than placebo in severe depression.¹

The efficacy CBT and IPT (as opposed to supportive companionship) remains uncertain.

A Contemplative 12 Steps
THE DHARMA ACCORDING TO BILL AND BOB

1. SUFFERING IS UNIVERSAL
   “We admitted we were powerless over alcohol - that our lives had become unmanageable.”

2. ATTACHMENT IS THE ORIGIN OF SUFFERING
   Suffering is caused by craving (for base objects, goals, desires)

3. SUFFERING IS NOT INEVITABLE
   Came to believe that a power greater than ourselves could restore us to sanity

4. THE DHARMA IS THE PATHWAY TO ESCAPING THE CYCLE OF SUFFERING.
   Made a decision to turn our will and our lives over to the care of God as we understood him.
1. RIGHT VIEW
  - understanding suffering
  - understanding its origin
  - understanding its cessation
  - understanding the way leading to its cessation.

(4) Made a searching and fearless moral inventory of ourselves

2. RIGHT INTENTION
  - intention of renunciation
  - intention of good will
  - intention of harmlessness

(5) Admitted to God, to ourselves, and to another human being the exact nature of our wrongs.

(6) Were entirely ready to have God remove all these defects of character

(7) Humbly asked Him to remove our shortcomings.

3. RIGHT SPEECH
  - abstaining from false speech
  - abstaining from slanderous speech
  - abstaining from harsh speech
  - abstaining from idle chatter
4. RIGHT ACTION

- abstaining from taking life
- abstaining from stealing
- abstaining from sexual misconduct

(8) Made a list of all persons we had harmed, and became willing to make amends to them all.
(9) Made direct amends to such people wherever possible, except when to do so would injure them or others.
(10) We tried to carry this message to alcoholics, and to practice these principles in all our affairs.
5. RIGHT LIVELIHOOD
- giving up wrong livelihood
- one earns one’s living by a right form of livelihood

6. RIGHT EFFORT
- the effort to restrain defilements
- the effort to abandon defilements
- the effort to develop wholesome states
- the effort to maintain wholesome states

(10) Continued to take personal inventory and when we were wrong promptly admitted it
7. RIGHT MINDFULNESS

- mindful contemplation of the body
- mindful contemplation of feelings
- mindful contemplation of the mind
- mindful contemplation of phenomena

(11) Sought through prayer and meditation to improve our conscious contact with God as we understood him, praying only for knowledge of His will for us and the power to carry that out.

8. RIGHT CONCENTRATION

- the first jhana
- the second jhana
- the third jhana
- the fourth jhana

(12) Having had a spiritual awakening as the result of these actions, we had a spiritual awakening and carried the message to others.
The Inner Tradition of Healing
-The Next Great Technological Revolution-
“This is the psychology everyone will be studying in twenty-five years” Harvard 1904

William James

Dharamapala Anagarika
Mind and Life XVIII
Attention, Memory and the Mind
A Synergy of Psychological, Neuroscientific and Contemplative Perspectives
April 6–10, 2009 • Dharamsala, India

“The field of research on meditation practices and their therapeutic applications is beset with uncertainty ....... Firm conclusions on the effects of meditation practices in healthcare cannot be drawn based on the available evidence.”
“Overall, although preliminary evidence suggests MM efficacy and safety, conclusive data for MM as a treatment of SUDs are lacking. Significant methodological limitations exist in most studies. Further, it is unclear which persons with SUDs might benefit most from MM. Future trials must be of sufficient sample size to answer a specific clinical question and should target both assessment of effect size and mechanisms of action”.

Mindfulness Meditation for Substance Use Disorders: A Systematic Review

Aleksandra Zgierska
Substance Abuse 2009
CHALLENGES IN RESEARCHING MEDITATION

- First-person phenomenology
- Variability in expertise
- Sample sizes
- Multiple techniques
- Limitations of neurotechnology
- Trans-verbal consciousness
- Very limited funding
Meditation as the Technology of Attention

“When examining a tapestry in a dark room, if you illuminate it with a radiant steady lamp, you can vividly examine the images. If the lamp is dim, or, though bright, flickers in the wind, your observation will be impaired. Likewise, when analyzing the nature of any phenomenon, supporting penetrating intelligence with unwavering, sustained, voluntary attention, and you can clearly observe the real nature of the phenomenon under investigation”

Tsongkhapa (1357-1419)
Together, results show that regular meditation is associated with more accurate, efficient, and flexible visual attentional processing across diverse tasks that have high face validity outside of the laboratory. Furthermore, effects were assessed in a context separate from actual meditation practice, suggesting that meditators’ better visual attention is not just immediate, but extends to contexts separate from meditation practice.

Disorganized? Distracted? Discombobulated? Doctors say you may have attention deficit disorder. It's not just kids who suffer from it.

Distracted: The Erosion of Attention and the Coming Dark Age
Maggie Jackson
Foreword by Bill McKibben
Author of The End of Nature and The Bill McKibben Reader
“The faculty of bringing back a wandering attention over and over again is the very root of judgement, character, and will. Any education which should improve this would be an education par excellence.”

William James
TYPES OF MEDITATION

- **CONCENTRATIVE** - Samatha
  Aims to stabilize attention to object (PERCEPTION)

- **INSIGHT-ORIENTED** - Vipassana
  Aims to stabilize subjective experience (CONCEPTION)

- **CYBERNETIC** *(Transformative)*
Perception Conception

Primary/Unimodal Association
Sensory Cortices
“Exteroceptive”

Hetermodal Association
“Interoceptive”

Conception
Vipassana
Cybernetic

Samatha
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<th>TECHNIQUE</th>
<th>TYPE</th>
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<td>JAPA</td>
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<tr>
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<td>C</td>
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<td>RAJA YOGA</td>
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<td>TM</td>
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<tr>
<td>ZEN</td>
<td>ZAZEN</td>
<td>1 - C</td>
</tr>
<tr>
<td>CHRISTIAN</td>
<td>Prayer of Heart</td>
<td>C</td>
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<tr>
<td>THERAVADA</td>
<td>VIPASSANA</td>
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<tr>
<td>TIBETAN</td>
<td>VAJRAYANA</td>
<td>1 - T - C</td>
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**Typology of Meditation Traditions and Techniques**
Contemplative Model of Health and Disease

"It is not the strongest of the species that survives, but rather the one most responsive to change."

Charles Darwin

ATTENTION

Dysregulation (Allostasis)
Disharmony (Allostasis)
Hormesis
Harmony (Homeostasis)

Disease
Disintegration
LEVELS of DISEASE in CHINESE MEDICINE

External pathogenic energy invades the layers of the body from the outer most to the innermost.

- Taiyin (Lu&Sp)
- Shaoxin (Li&Kj)
- Yangming (ST&Co)
- Shaoyang (GB&Shi)
- Taiyang (SI&Bl)

精气神
Indicators of Green Zone Capacity

- Inflammatory Markers (cytokines, homocysteine, CRP)
- HRV and Sinus Arrhythmia
- Telomere length and Telomerase Activity
- Biometrics (waist, BMI, exercise tolerance)
- Inflammation
- Oxidation
- Glycation
- Methylation
LIFE IS A BINARY SYSTEM

Balance is the Key to Life
ALLOSTASIS equals ALLESTHESIA in Behavioral Terms

Paulson M and Stein S. Biological Psychiatry 2009
N.B ALLESTHESIA
The progression of alcohol dependence over time, illustrating the shift in underlying motivational mechanisms. From initial, positive reinforcing, pleasurable alcohol effects, the addictive process progresses over time to being maintained by negative reinforcing relief from a negative emotional state. Data presented in this paper suggest that neuroadaptations encompassing the recruitment of extrahypothalamic CRF systems are key to this shift. (Taken with permission from Heilig and Koob 2007.)

The a-process represents a positive hedonic or positive mood state, and the b-process represents the negative hedonic or negative mood state. The affective stimulus (state) has been argued to be the sum of both the a-process and b-process. An individual who experiences a positive hedonic mood state from a drug of abuse with sufficient time between re-administering the drug is hypothesized to retain the a-process. An appropriate counteradaptive opponent process (b-process) that balances the activational process (a-process) does not lead to an allostatic state. The changes in the affective stimulus (state) in an individual with repeated frequent drug use may represent a transition to an allostatic state in the brain systems and, by extrapolation, a transition to addiction (see text). Notice that the apparent b-process never returns to the original homeostatic level before drug taking begins again, thus creating a greater and greater allostatic state in the brain emotional systems. The counteradaptive opponent-process (b-process) does not balance the activational process (a-process) but in fact shows a residual hysteresis. Although these changes illustrated in the figure are exaggerated and condensed over time, the hypothesis is that even during post-detoxification (a period of "protracted abstinence"), the brain emotional systems still bear allostatic changes (see text). The following definitions apply: allostasis, the process of achieving stability through change; allostatic state, a state of chronic deviation of the regulatory system from its normal (homeostatic) operating level; allostatic load, the cost to the brain and body of the deviation, accumulating over time, and reflecting in many cases pathological states and accumulation of damage. (Modified with permission from Koob and Le Moal 2001.)

Maldonado 2011 The neurobiology of Addiction KOOB 2011
Paulson M and Stein S. Biological Psychiatry 2009
Is Meditation Simply Relaxation?

The Relaxation Response
by Herbert Benson, M.D.
with Miriam Z. Klipper

A simple meditative technique that has helped millions to cope with fatigue, anxiety and stress

Nationwide Bestseller

Author of "Beyond the Relaxation Response"
Zazen and Cardiac Variability
Lehrer P. et al, Psychosomatics 1999
Meditation experience is associated with increased cortical thickness

Lazar S. et al. NeuroReport 2005, 1893-1897

20 long-term insight meditators (9.1+/−7.1 years; 6.2+/− hours per week) - 15 controls

Overall cortical thickness between groups not significantly different

Statistically increased thickness in the

**Right prefrontal cortex**  **right anterior insula cortex**

Most significant difference in older subjects i.e. aging protection

Increased thickness correlates with experience i.e. dose effect

Replicated by Luders et al. Neuroimage 2009
Gray matter concentration at the medial orbitofrontal cortex correlates with total hours of meditation training.

Bridging the hemispheres in meditation: Thicker callosal regions and enhanced fractional anisotropy (FA) in long-term practitioners

Eileen Luders Luders et al. Neuroimage May 2012
Effects of meditation on frontal alpha-asymmetry in previously suicidal individuals.

Barnhoger T et al. Neuoreport 2007
Alterations in Brain and Immune Function Produced by Mindfulness Meditation

Richard J. Davidson, PhD, Jon Kabat-Zinn, PhD, et al.
Psychosomatics 2002

Increased left-sided activation to both positive and negative affect induction C3/4 p<0.05

Greater rise in antibody titers response to influenza vaccine p<0.05
Meditation Reduces Self-Referential Executive Cognition

AFFECTIVE LABELING >>> Activation of MesioFrontal PreFrontal Cortex >>> Activation of of RVL Prefrontal Cortex >>> Inhibition of Amygdala Response

i.e. Diminished Self-Referential Reactivity

- Moving from Reactivity to Reflexivity -

Experiential vs Narrative focus conditions following 8 weeks of MT


Social Cognitive and Affective Neuroscience
Gamma Synchrony with non-referential compassion meditation (transformational meditation practice) - Lutz, Davidson et al. PNAS 2004
Interpretation of EEG Studies

- Meditative practices result in an attentional state characterized by **LEFTFRONTALACTIVATION** and "cortical tuning" in which non-relevant cortical functions are inhibited (alpha/theta synchronization and slowing) while specific (meditation-type specific) neural networks are enhanced (gamma synchronization). This state of relaxed attentiveness appears to be trainable - producing both state and trait effects. These states/traits appear to correlate with positive mood states. The mechanism remains unclear but most likely involves the selective activation of segmented thalamo-cortical circuits.
One year pre-post intervention follow-up of psychological, immune, endocrine and blood pressure outcomes of mindfulness-based stress reduction (MBSR) in breast and prostate cancer outpatients.

Carlson LE, Speca M, Patel KD, Faris P.

Brain, Behavior, Immunity May 2007
“Estimating the effect on QoL, a total of n = 248 patients out of 6 studies was included and the overall effect size was 0.29 (95\% confidence interval (CI) 0.17–0.40; \( p \leq 0.00005 \)). Calculating the effect on mood, a total of n = 411 patients out of ten studies were included, and the overall effect size was 0.42 (95\% CI 0.26–0.58; \( p < 0.0001 \)). Reduction in distress revealed an overall effect size of 0.58 (95\% CI 0.45–0.72; \( p < 0.0001 \); n = 587 patients out of 15 studies). MBSR programmes can improve QoL and mood, and reduce distress in cancer patients.”

Mindfulness-Based Stress Reduction for Integrative Cancer Care – a Summary of Evidence
Musial et al. Forschende 2011
Intensive meditation training, immune cell telomerase activity, and psychological mediators
Jacobs TL. Psychoneuroendocrinology. 2010.
Effect of compassion meditation on neuroendocrine, innate immune and behavioral responses to psychosocial stress

T. Pace at al. 2008
SYNOPSIS OF MEDITATION RESEARCH

- Exert anti-inflammatory effects
- Produce activation and enhancement of saliency and executive networks
- Produce epigenetic changes
- Support homeodynamic resilience
“Mindfulness promotes an objective manner of interpreting thoughts, events and emotions, without elaborating or ‘ruminating’ on their potential implications for the self”

Messengers versus Roadmaps
Default Mode Network
Taylor et al. 2012 Social and Affective Cognitive Science
Two independent control networks identified using intrinsic physiological coupling in fMRI data. The salience network (shown in red) is important for monitoring the saliency of external inputs and internal brain events, and the central executive network (shown in blue) is engaged in higher-order cognitive and attentional control. The salience network is anchored in anterior insular and anterior cingulate cortices and features extensive connectivity with subcortical and limbic structures involved in reward and motivation. Central executive network links the dorsolateral frontal and parietal neocortices, with subcortical coupling that is distinct from that of the salience network (adapted from Seeley et al. 2007).
Meditation experience is associated with differences in default mode network activity and connectivity.

Experienced meditators demonstrate decreased DMN activation during meditation. Brain activation in meditators > controls is shown, collapsed across all meditations (relative to baseline). (A and B) Activations in the left mPFC and PCC. (C and D) Average percent signal change (± SD) during individual meditation conditions in the mPFC and PCC, respectively: Choiceless Awareness (green bars), Loving-Kindness (red), and Concentration (blue) meditations. Note that decreased activation in PCC in meditators is common across different meditation types. n = 12 per group.
“Neuropsychiatric disorders are associated with abnormal function of the default mode network (DMN), a distributed network of brain regions more active during rest than during performance of many attention-demanding tasks and characterized by a high degree of functional connectivity (i.e., temporal correlations between brain regions). Functional magnetic resonance imaging studies have revealed that the DMN in the healthy brain is associated with stimulus-independent thought and self-reflection and that greater suppression of the DMN is associated with better performance on attention-demanding tasks. In schizophrenia and depression, the DMN is often found to be hyperactivated and hyperconnected. In schizophrenia this may relate to overly intensive self-reference and impairments in attention and working memory. In depression, DMN hyperactivity may be related to negative rumination”.

Meditation experience is associated with differences in default mode network activity and connectivity

Meditation experience is associated with differences in default mode network activity and connectivity

Brewer JA et al. PNAS 2011 108 (50) 20254-20259

Experienced meditators demonstrate coactivation of PCC, dACC, and dIPFC at baseline and during meditation. Functional connectivity with the PCC seed region collapsed across all meditation conditions, is shown in (A and I) controls at baseline; (B and J) meditators at baseline; (C and K) meditators > controls at baseline; (E and M) controls during meditation; (F and N) meditators during meditation; (G and O) meditators > controls during meditation. Connectivity z-scores (± SD) are shown (D) for dACC cluster from C; (H) for dACC cluster from G; (L) for left dIPFC cluster from K; and (P) for right dIPFC cluster from K. Baseline (white bars), Choiceless Awareness (green bars), Loving-Kindness (red bars), and Concentration (blue bars) meditation conditions are shown separately for meditators (Left) and controls (Right). n = 12/group. FWE-corrected, P < 0.05.
Experienced meditators demonstrate coactivation of mPFC, insula, and temporal lobes during meditation. Differential functional connectivity with mPFC seed region and left posterior insula is shown in meditators > controls: (A) at baseline and (B) during meditation. (C) Connectivity z-scores (±SD) are shown for left posterior insula. Choiceless Awareness (green bars), Loving-Kindness (red), and Concentration (blue) meditation conditions are shown separately. For each color, baseline condition is displayed on the left and the meditation period on right. n = 12/group. FWE-corrected, P < 0.05.
“As predicted, across all mindfulness meditation conditions, the two primary nodes of the DMN (the PCC and mPFC) were less active in meditators than controls. We also observed meditation-specific regional differences in activation patterns, such as deactivation in the amygdala during Loving-Kindness. Finally, using DMN seed regions, we observed distinct functional connectivity patterns in meditators that differed from controls, and which were consistent across resting-state baseline and meditation conditions. These results suggest that the neural mechanisms underlying mindfulness training are associated with differential activation and connectivity of the DMN. As meditators also reported significantly less mind-wandering, which has been previously associated with activity in the DMN, these results support the hypothesis that alterations in the DMN are related to reduction in mind-wandering. Finally, the consistency of connectivity across both meditation and baseline periods suggests that meditation practice may transform the resting-state experience into one that resembles a meditative state, and as such, is a more present-centered default mode”.

Meditation experience is associated with differences in default mode network activity and connectivity
Brewer JA et al. PNAS 2011 108 (50) 20254-20259
“The highest form of human intelligence is to witness oneself without judgement”
Deepak Chopra
“Relative to beginners, experienced meditators had weaker functional connectivity between DMN regions involved in self-referential processing and emotional appraisal. In addition, experienced meditators had increased connectivity between certain DMN regions (e.g. dorso-medial PFC and right inferior parietal lobule), compared to beginner meditators. These findings suggest that meditation training leads to functional connectivity changes between core DMN regions possibly reflecting strengthened present-moment awareness”.

Impact of meditation training on the default mode network during a restful state
Veronique A. Taylor et al. SCAN March 2012
“Addictive drug use is often related to abnormal functional organization in the users’ brain, which leads to habitual hypersensitivity to drug-related cues and ensures their compulsive patterns of drug-seeking behavior. The brain circuits of memory and learning, including the hippocampus, and cognitive control, involving the dorsal anterior cingulate cortex, are believed to be impaired in addiction. As a result, under addiction, saliency value of drug-related cues are enhanced, while inhibitory controls are weakened, setting up the stage for an unrestrained cycle which leads to compulsive drug-seeking without regard to its negative consequences.”

Ning Ma et al. PLoS One 2011
Abnormal Brain Default-Mode Network Functional Connectivity in Drug Addicts

Ning Ma1**, Ying Liu2#, Xian-Ming Fu3, Nan Li1, Chang-Xin Wang2, Hao Zhang4, Ruo-Bing Qian3, Hu-Sheng Xu1, Xiaoping Hu5, Da-Ren Zhang1

CAS Key Laboratory of Brain Function and Disease, and School of Life Sciences, University of Science and Technology of China, Hefei, China, PLoS One January 2011
Abnormal Brain Default-Mode Network Functional Connectivity in Drug Addicts
Ning Ma et al. PLoS January 2011

Figure 2. Altered Functional Connectivity of the Default-Mode Network in Heroin Users.
“Taken together, the abnormality of functional connectivity of the DMN we found in drug addicts suggest drug addicts' altered functional organization of the DMN, which may be implicated in addiction-related increased memory processing (hippocampus) and diminished cognitive control (ACC and caudate) related to attention and self-monitoring. These notions may underlie the addicts' hypersensitivity to drug related cues and weakened strength of cognitive control.”

Ning Ma et al. PLoS One February 2011

i.e. Decreased Executive Network Supervision and Increased Saliency Sensitivity
Meditation-induced changes in high-frequency heart rate variability predict smoking outcomes

Daniel J. Libby  Frontiers Neuroscience. March 2012
Insula involvement in nicotine addiction and attentional processes. (A) Greater gray matter density in smokers (n = 48) relative to matched controls in the left insula. (B) Increased insula activity to smoking-related versus neutral cues is positively correlated with attention to smoking-cues in an affective Stroop task. (C). Difference map and bar graph illustrating enhanced BOLD deactivations in the insula under nicotine relative to placebo conditions during a sustained attention task (RVIP) but not a sensorimotor control task in minimally deprived (~ 3 h) smokers.
When salient moments occur rapidly, the number of global emotional moments increases during that time and, as a consequence, subjective time dilates.
“Samsara and Nirvana have no other difference than that between the moment of being unaware and being aware .. Since we are not deluded by perception but by fixation, Liberation naturally occurs when we recognize that fixed thoughts are only mind grasping at its on empty reflections.”

Padmasambhava - Liberation Through Seeing with Naked Awareness
“The Dark Times will be a time when human beings no longer have any space between his thoughts”
Tibetan Prophecy