Working memory for cognitive control in Anorexia versus Addiction: A Bayesian Brain perspective

drsamanthabrooks.com
Outline of my talk

• Impulse control at opposing extremes
• Neuroscience of impulse control
• Bayesian Brain and impulse control
• Translational neuroscience
• Some data
• Questions unanswered
• Conclusions
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Impulse control at opposing extremes
What can we learn from anorexia nervosa?

- **Restrictive**: Restriction and control of appetite
  - Binge-Purge
  - Anorexia Nervosa
- **OCPD**: Perfectionism, Cognitive Rigidity, Attention to detail (Anxiety)
- **High arousal**: Aversive social situations, Promiscuity, Alcoholism (Anxiety)
- **Impulsive**: Lack of control and an excessive appetite
  - Non-Purge Bulimia Nervosa
  - Binge-Purge Bulimia Nervosa

**Genetic Markers**
- DLPFC
- OFC
- MPFC
- ACC
- COMT
- 5HT2A
- dorsal striatum
- amygdala
- cerebellum
- hypothalamus
- Genetic Markers
  - BDNF
  - 5HT2A
Restraint extreme
Impulsivity extreme
What might “normalcy” look like?
Impulse Control or “Conscious Veto”

How might people with anorexia nervosa sustain ‘conscious veto’ otherwise known as FREE WON’T? And why can’t impulsive people do it?

Brooks et al., (2012)
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Neuroscience of impulse control

“Individual’s with Anorexia are protected from developing Substance Use Disorder”
Kaye et al., 2013 – Biological Psychiatry

“Nothing tastes as good as skinny feels”
Kaye et al., 2013 – Trends Neurosci
Neuroscience of impulse control

A. Brain reward pathways
- Prefrontal cortex (PFC)
- Cingulate gyrus (CG)
- Striatum
- Nucleus accumbens (NAc)
- Ventral tegmental area

B. Non-addicted brain
- Control & Self-regulation (PFC, CG)
- Salience (NAc)
- Drive (OFC)
- Memory (Am, Hip)

C. Addicted brain
- Control & Self-regulation (PFC, CG)
- Salience (NAc)
- Drive (OFC)
- Memory (Am, Hip)
Neuroscience of impulse control

The striatum problem of addiction

BRAIN RECOVERY WITH PROLONGED ABSTINENCE

Healthy Person

METH Abuser 1 month abstinence

METH Abuser 14 months abstinence
Neuroscience of impulse control

Dopamine Pathways

Frontal cortex
- Reward (motivation)
- Pleasure, euphoria
- Motor function (fine tuning)
- Compulsion
- Perseveration

Functions
- Mood
- Memory processing
- Sleep
- Cognition

Serotonin Pathways

Striatum
Substantia nigra
Nucleus accumbens
VTA
Hippocampus
Raphe nucleus
Neuroscience of impulse control

MRI Scans of Healthy Children and Teens Over Time

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Neuroscience of Impulse Control

RESTRICTIVE
ANOREXIA

I won't eat

NORMALCITY

IMPULSIVE

Working Memory

Cognitive restraint

Neuroimaging data showing differences in brain activity between obese and normal-weight individuals in response to cognitive restraint tasks.
To reference - Please Link to the source website: loopa.co.uk

Prefrontal Cortex

LIBET’S HALF SECOND

Potential

Bereitschaftspotential

Time
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Epistemic foraging...

...Versus Jumping to Conclusions

There are two jars: A mainly orange jar containing 85 orange and 15 black beads and a mainly black jar containing 85 black and 15 orange beads.

The beads have been mixed up in the jar.

The first bead drawn is:

Would you like to see any more beads or have you decided now?

The Beads Task as seen on-screen. Pink represents the orange viewed by participants.
The Bayesian Brain (Friston)

“Would anybody like to take part in our study?”
The Bayesian Brain, Epistemic Foraging vs. Jumping to Conclusions in Anorexia Nervosa Vs. Substance Use Disorder

**Absorber:**
Analogy for anorexia nervosa

**Pump:**
Analogy for Substance use disorder
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Translational Neuroscience

https://youtu.be/AZBwA8Oc_Ic
Libet’s half second experiments hinted that people can exercise “Conscious Veto” over their unconscious processes (such as appetite).

Building up the cognitive machinery for “Conscious Veto” with working memory training.
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Experimental paradigm

**TREATMENT PROGRAMME**
- Elements of Dialectical Behaviour Therapy (DBT)
- Psycho-education
- Hypo-caloric refeeding (>3500 calories) / 6 meals
- Physical exercise
- Mindfulness
- Group and one-to-one therapy sessions

**8 WEEKS' IN-PATIENT PROGRAMME AT THE ADDICTION REHABILITATION CENTRE**

**ORTIENTATION PHASE**
- Clinical assessments
- Re-feeding
- No research contact

**THERAPEUTIC PHASE**
- Week 3 + 6: 1 hour MRI session and 1 hour questionnaire
- TAU: 4 weeks' treatment programme. Do not have cognitive training
- TAU + CT: Daily cognitive training weeks 3-6 in afternoons (30 minutes per day; 5 x 5 minutes with 1 minute break)

**DISCHARGE PHASE**
- Clinical assessments
- Life-skills training
- No research contact

Brooks et al., (2017) Psychopharmacol; 234(12):1911-1921
Brooks et al., (2017) Psychopharmacol; 234(12):1911-1921

Experimental paradigm

@ Week 3 and Week 6

s/f MRI

Questionnaires
- Impulsivity
- Self-control
- Mood
- Anxiety
- Depression
- Self-regulation

Treatment as usual with DBT Psycho-education
Re-feeding
N=15

Cognitive training App over 4 weeks, 30 minutes daily
N=20

Therapeutic Phase
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- TAU: 4 weeks’ treatment programme. Do not have cognitive training
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  (30 minutes per day: 5 x 5 minutes with 1 minute break)
What happened during cognitive training?

Brooks et al., (2017) Psychopharmacol; 234(12):1911-1921
What happened during cognitive training?

**PSYCHOLOGICAL DIFFERENCES**

Brooks et al., (2017) Psychopharmacol; 234(12):1911-1921
Structural MRI data

VOLUME DIFFERENCES

TREATMENT AS USUAL (TAU) Vs. WM TRAINED (WMT)

Some data from our group

VOLUME DIFFERENCES PREDICTING CHANGE

TOTAL BASELINE GROUP: LARGER LEFT MIDDLE FRONTAL GYRUS VOLUME PREDICTS IMPROVED SELF REGULATION QUESTIONNAIRE (SRQ) SCORE AT FOLLOW-UP

Brooks et al., under review. NeuroImage: Clinical
TOTAL FOLLOW-UP GROUP: LARGER BRAINSTEM VOLUME REFLECTS IMPROVED SELF-CONTROL SCORES FROM BASELINE.

Structural MRI data

VOLUME DIFFERENCES PREDICTING CHANGE
Brooks et al., “hot off the press”

FUNCTIONAL DIFFERENCES

Structural MRI data

Meth patients (before treatment) > Healthy Controls
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Brooks et al., (2017)
Frontiers in Psychology: Cognition
Questions unanswered

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- What is the most effective way to measure unconscious processes in the brain?

Brooks et al., (2017)
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Cognition
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- Are there instances where prefrontal cortex is activated without conscious awareness/engagement?

Brooks et al., (2017)
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- Does psychiatric disorder originate in bottom up unconscious or top down conscious processes?

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- Does psychiatric disorder originate in bottom up unconscious or top down conscious processes?
- What are the neural correlates of a conscious veto ("free won’t") process after the readiness potential?

Brooks et al., (2017)
Frontiers in Psychology: Cognition
Questions unanswered

- Transcranial Magnetic Stimulation
- Real-time functional MRI
- Imaging epigenetics
- Imaging with subliminal paradigms
- Working memory paradigms

Brooks et al., (2017)
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Conclusions

How might people with anorexia nervosa sustain ‘conscious veto’ otherwise known as FREE WON’T?

And why can’t impulsive people do it?
• Appetitive stimulations are non-consciously activated (perhaps half a second before consciousness)

• Those with anorexia nervosa exercise complex ruminations (epistemic foraging) that act as a conscious veto over appetite

• Repetitive working memory supports epistemic foraging that updates predictions about the future (Bayesian Brain)

• Neuroplasticity related to epistemic foraging might help to control behaviour (compulsions)

• REPEAT: “Working memory training may foster such neuroplasticity”
Impulse Control = Creativity

Impulse control - not what it seems;
Not what it sounds -
It doesn’t kill dreams.

Controlling impulses – like singing a song;
Tune doesn’t go wrong -
To a noisy throng.

Impulsivity - allows not delay;
Can’t mind the gap -
Thoughts kept in a trap.

Self-control – fosters creativity;
Rodin perched observing city -
Of dreams for eternity.

No imagination - without impulse control;
Stimulus-response becomes very droll -
Without gap or delay you’re stuck in a hole.

Creativity builds – vision in mind;
Impulsivity renders vision blind –
Control supports vision to find.

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Thanks for your attention!

THANK YOU!

СПАСИБО!

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