Mindfulness and Attention

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Mindfulness meditation practice

Meditation:

“self-regulation practices that focus on training attention and awareness in order to bring mental processes under greater voluntary control and thereby foster general mental well-being and development and/or specific capacities such as calm, clarity, and concentration”. (Walsh & Shapiro, 2006)

Mindfulness meditation:

“The heart of the practice is to cultivate a dispassionate, observant state of mind, where all arising thoughts and emotions are recognised as mental events without ascribing any specific value to them.” (Malinowski, 2008)

ATTENTION
in (mindfulness) meditation practice
Mindfulness and introspection are taught, for the first prevents attention from straying from the meditative object, while the second recognizes that the attention is straying.

**smṛti** (tib.: dran pa) mindfulness; recollection; retention; sustaining the attention upon an object without being distracted

**samprajñāna** (tib.: shes bzhin) introspection, ‘clear comprehension’, reflective knowledge of one’s mental and bodily states; “meta-cognition”

**manasikāra** orienting of attention towards object and selecting it


Samatha

Quiescence / calm abiding

*a serene attentional state in which the hindrances of excitation and laxity have been thoroughly calmed*


Novice Meditators
Incentive Novice Meditators
Experienced Meditators
Least Hours Experienced Meditators
Most Hours Experienced Meditators

Stages of Samadhi *(Kamalashila)*

1. Directed attention
2. Continuous attention
3. Resurgent attention
4. Close attention
5. Tamed attention
6. Pacified attention
7. Fully pacified attention
8. Single-pointed attention
9. Attentional balance
10. Shamatha

Stages of Samadhi (*Kamalashila*)

1. 
2. 
3. Resurgent attention  
   *One still forgets the meditative object entirely for brief periods*
4. 
5. 
6. 
7. Fully pacified attention  
   *Subtle imbalances of attention swiftly rectified*
8. Single-pointed attention  
   *Still takes effort to ward off excitation and laxity*
9. 
10. 

8. Single-pointed attention

You can now sustain a high level of samadhi, or highly focused attention, free of the imbalances of even the subtlest laxity and excitation for at least three hours or so. Only the slightest degree of effort at the beginning of each session is needed to ward off these obstacles, and you continue in your practice motivated by the power of enthusiasm.

Beyond ‘mindfulness proper’

**Non-dual Mindfulness**

*From the non-dual Innateist perspective, if one is cultivating smṛti (Pali, sati) and manasikāra, then one is cultivating ignorance because one is only strengthening the subject-object structures of awareness – the very structures that are the subtlest manifestation of ignorance itself.*

(Dunne, 2011, p.77)

ATTENTION
in cognitive neuroscience
Networks of Attention

- **Alertness**
  - Raising one's state of alertness
  - Sustaining one's alertness

- **Orienting**
  - Shifting focus to new content / object / experience
  - Disengaging focus from content / object / experience

- **Executive Control**
  - Resolving conflict
  - Monitoring responses
  - Shifting/switching between task sets

The three attention networks

WHAT HAPPENS DURING MEDITATION?
Mind wandering and attention during focused meditation

Event-related potentials (ERPs)
Reduced distraction during meditation

Auditory oddball paradigm

Standard Tone (80%)

Oddball Tone (10%)

White Noise Distracter (10%)

Reduced distraction during *Vipassana* meditation

**Control Condition**
*(free-wandering non-emotional thoughts)*

**Meditation Condition**
*(body scan a la S.N. Goenka)*

➔ ERPs to distractor stimuli during *Vipassana* meditation reduced compared to control condition
➔ Reduced automated reactivity and evaluative processing

TRANSFER TO ‘OUTSIDE’ OF MEDITATION?
Sustained attention after meditation retreat

The attentional blink effect

Event-Related Potentials: more balanced attention

In ‘no-blink’ trials the P3b amplitude for T1 became reduced
⇒ Attention is allocated more consistently over time

Less resource-demanding stimulus processing

Participants with the largest reduction in the P3b also showed the largest reduction of the timing variability of the theta oscillation (4–8 Hz) after successful detection of T2.

Meditation may lead to more consistent and less resource-demanding stimulus processing.

Challenging sustained attention

Multiple object tracking task:

- 1-4 circles marked
- 1 circle probed

Mindful breath awareness (N=17) vs Progressive Muscle Relaxation (N=17)
6 x 1h sessions over 8 weeks; 10-15 minutes practice per day, at least 3 x per week
Steady-state visual evoked potentials (SSVEP) to index involved neural network activity

Reduced neural resources involved while performance improved

DOES (MINDFULNESS) MEDITATION IMPROVE META-COGNITIVE FUNCTIONS?

(transfer to ‘outside’ of meditation)
Three studies

1. 3 weeks mindful breath awareness vs waitlist control

2. 8 weeks mindful breath awareness vs brain gym (55-75yrs)

3. 16 weeks mindful breath awareness vs waitlist control
Inhibitory Control

 Override the pre-potent response
 (to respond differently)

 Inhibit the pre-potent response
 (to stop execution)

 Meta-cognitive control

 Monitoring

 Performance monitoring
 Observe accuracy

 Response monitoring
 Observe response selection

 for personal use only
INHIBITORY CONTROL: Overriding the pre-potent response
Posterior N2-Effect (160 – 240ms)

16 weeks

Posterior P3 (310 – 380ms)

Control processes involved in overriding automatic responses require less resources

Localisation of differences ($T3 - T1$)

**Increased attentional focus**

$(N2; 160 - 240ms)$

- **Congruent**
- **Incongruent**

**Reduced neural resource requirements**

for resolving stimulus conflicts

$(P3; 310 - 380ms)$

- **Congruent**
- **Incongruent**

**Control Group**

**Meditation Group**

INHIBITORY CONTROL

Inhibiting a pre-potent response
P3 ERP component:
Index of inhibiting response execution
(go-nogo task)

Fixation

Target

Blank

500ms

“GO!” (75%)

“NOGO!” (25%)

0 100 200 300 400 500
stimulus msec

P3

Go

noGo

3 weeks

3 weeks

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41
Fronto-central no-go P3a:

3 weeks

75% 25%

Improved response inhibition

Pozuelos, et al. – manuscript in preparation
fronto-central nogo P3a

Go (60%)
No-Go (40%)

Improved response inhibition
(in older adults)

Malinowski et al. – manuscript in preparation
MONITORING
Of response selection
8 weeks

**Fronto-central N2 ERP**

- **TWO**
- **SAD**
- **FUN**
- **BOX**

- **incongruent**
- **negative**
- **positive**
- **neutral**

**amplitude (µv)**

![Graph showing ERP amplitude over time](chart)

- T1
- T2

**Improved response monitoring**
**But no condition-specific effects**

*in older adults*

Malinowski et al. – in revision
MONITORING

Of performance / response accuracy
Error Related Negativity (ERN)

- Fronto Central Negativity
- 0-100 ms after response

Teper, M., & Inzlicht, M. (2013) SCAN

Fronto-central ERN ("false alarms")

Correlation with practice time:
\[ r = -0.626 \]

Improved performance monitoring
Summary: “meta-cognitive effects”

Clear indication of functional plasticity of meta-cognitive functions

- **Inhibitory Control**
  - Overriding
  - Inhibiting execution

- **Monitoring**
  - Response selection
  - Performance

The transfer from meditation practice to performance on tasks ‘outside’ of meditation needs to be studied.
THE LINK TO AFFECTIVE PROCESSES
Error Related Negativity (ERN)

Feedback Related Negativity (FRN)

“press button when 1 sec has passed”

Teper, M., & Inzlicht, M., (2013) SCAN

FRN Difference Wave

Rewarding feedback

Aversive feedback

High levels of non-judgemental acceptance

less reactivity to immediate reward feedback
Summary

• Various aspects of sustained attention and of executive control functions are improved by simple, brief mindfulness meditation practice.

• Engaging/training cognitive core processes during meditation appears to generalise to performance and neural activity outside of meditation

• First studies investigating the link between attentional and affective processes are being investigated
People involved...

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Thank you!

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