A conceptual mediation hypothesis of synaesthesia: What can yellow Tuesdays tell us about how we represent objects?

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Synaesthesia

- Perception of a specific stimulus induces a concurrent and distinct experience in a separate modality, or within the same modality

- Neural hypotheses:
  - Synaesthetes have extra connections between relevant brain areas
  - Synaesthetes have disinhibition of connections present in us all

=> Neuroimaging thus far has primarily focused on early perceptual regions (V4)
Why study synaesthesia?

Hypothesis: synaesthetic links are (1) conceptual; and (2) analogous to links between object features.
The evidence for higher-level processes at work in synaesthesia...

**INDUCER:**

- Concept of an inducer can elicit synaesthesia
- Attended inducer determines experience
- Context determines the experience
- Conceptual links can overcome usual letter-based colours
- Need substantial processing (~conscious identification) to elicit synaesthesia

\[5 + 2 = \text{Dixon et al. (2000)}\]

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\text{e.g., Rich & Mattingley (2003)}

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\text{e.g., Myles et al. (2003); Dixon et al. (2006)}

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T_2 \text{ Alone} & T_2 \text{ after } T_1 & & & & \\
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\end{array}
\text{Rich et al. (2005)}

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\end{array}
\text{Rich & Mattingley (2010)}

\text{T, TEST, TWO, 2}
The evidence for higher-level processes at work in synaesthesia...

EXPERIENCE:

- No brightness contrast or chromatic adaptation effects
  
  (Hong & Blake, 2008)

- Simultaneous colour contrast effects are not comparable with ‘real’ colour
  
  Nijboer et al. 2011

- No colour constancy effect
  
  Erskine et al. 2012

- Resemble recalled colours in precision
  
  Arnold et al. 2011

But didn’t Ramachandran & Hubbard show ‘pop-out’?

⇒ synaesthetic colours very early in perception of inducers

⇒ act like real colours
Testing for synaesthetic “pop-out”

Rich & Karstoft (2013)

Errors
A conceptual-mediation hypothesis of synaesthesia

Chiou & Rich (2014)
Does knowing the colour of a banana rely only on early perceptual regions?

- Distributed view: knowledge of object features relies only on relevant sensorimotor regions

- Hub+spoke view: an amodal hub holds abstract information about object features

- Patients with damage to the Anterior Temporal Lobe have semantic dementia

⇒ Amodal ‘hub’ holding conceptual knowledge? (Patterson/Lambon-Ralph)
A conceptual lemon?

Does knowledge of typical colour involve the ATL?

• Transcranial magnetic stimulation
  – More focal than patient lesions
  – Transient effects
  – Test the effect of ATL disruption on a task that measures object-colour knowledge

• Offline theta-burst stimulation
  – 40 secs TMS
  – Lasts ~15-30 mins

• ATL & Occipital pole (control site)
Behavioural measures

Object naming task

Quantity naming task
Is the ATL involved in object-colour binding?

Chiou et al. (in press)
A conceptual connection?
Disrupting synaesthetic colour-form binding

TMS: theta-burst

Anterior temporal lobe

lexical meaning; conceptual inducer-concurrent association

Parietal lobe

attention-related functions

Colour-related 'spoke'
subjective colour experience, which may not be equivalent to wavelength-based colour
Behavioural measures

Synaesthetic congruency

Quantity

Task: Name the display colour

Task: Name the quantity of digits

<table>
<thead>
<tr>
<th>Congruent</th>
<th>Incongruent</th>
</tr>
</thead>
<tbody>
<tr>
<td>600</td>
<td>700</td>
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<td>800</td>
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</table>

Mean correct RT (ms)

- Congruent: 600 ms
- Incongruent: 800 ms

Menzies Symposium ICON 2014
Preliminary results (3 synaesthetes)

Syn congruency measure

<table>
<thead>
<tr>
<th>Stimulation site</th>
<th>Congruency effect (Incong - Cong; ms)</th>
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<tbody>
<tr>
<td>ATL</td>
<td>Straight after stimulation</td>
</tr>
<tr>
<td>PPL</td>
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<td>OP</td>
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Quantity congruency measure

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