Phosphenes

Intensive Course in Transcranial Magnetic Stimulation

October 2016
Phosphene: definition

• From Greek *phōs* ‘light’ + *phainein* ‘to show’
• Brief visual percept “flash of light”
• Not caused by phototransduction
• But interpreted as visual stimuli

Modified from Bear, Connors, Paradiso, 1996
Phosphenes: causes

• Mechanical stimulation
  – Rubbing your eyes
  – “Seeing stars” from a blow to the head
  – Pituitary tumor encroaching on optic chiasm

• Electrical stimulation
  – Transcranial alternating current stimulation (tACS)
  – Transcranial magnetic stimulation (TMS)
Characteristics of TMS phosphenes

- Subjective experience
- Retinotopically organized
- Simple geometric shapes
- Appear as light (in darkness or eyes closed)
- Appear as blurring or scotoma (eyes open)

Figure 1. Artistic impressions of phosphenes reported by subjects. Left column: peripheral phosphenes (>5°); right column: central phosphenes (<5°). (a) Structured phosphenes: stripes, grids, or wavy lines; (b) sector-shaped light flashes, usually near the horizontal meridian, showing well defined edges; and (c) light flashes with indefinite edges ("blobs"): arcs, ovals, rectangles.

From Marg & Rudiak, 1994
Locating Phosphene Hotspot

- Find the inion
- Mark point 2cm dorsal and 2cm lateral
- Orient coil with handle pointing laterally  
  – Optimal current direction is lateral to medial (in brain)
- Phosphene should be reported in contralateral visual field

Optimal current direction: lateral to medial in brain
Assess Phosphene Threshold

• Follow same procedure as motor threshold
  – Begin subthreshold (e.g., 30% MSO)
  – Increase in steps of 10 until phosphene reported
  – Decrease in steps of 1-2 until occurrence < 50%
  – Count only unambiguous responses
    (“yes” or “no”), redo “maybe”
Considerations

• Can be easier if subject is blindfolded
• Have subject focus on center of visual field
  – Directing attention to a part of the visual field will decrease threshold to relative to rest of visual field
No significant correlation between motor and phosphene thresholds

From Gerwig et al., 2003, J Neurol Sci

From Fried et al., 2011, PLoS1

$r_{28} = 0.29, p > 0.1$

$r_{16} = 0.27, p > 0.2$
Neural basis of phosphene awareness

From Taylor et al., 2010, Human Brain Mapping