Eye Movements during Emotional Scene Processing:
Exploring the Role of Visual Perception in Intrusive Mental Imagery

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Background

Intrusive imagery symptoms of PTSD, OCD, & schizophrenia linked to maladaptive memory formation, abnormal visual processing, gaze pattern deficits, & baseline mental imagery abilities.

Current study measured eye movements & hemodynamic response (HDR) during Viewing & Imagining of Negative & Neutral scenes to test relationship of fixations & visual processing on immediate recreation of scenes & later intrusive imagery

Eye gaze moderated by emotional valence[1,2]

Decreased vividness of voluntary imagery associated with intrusive symptoms[3]

Playing Tetris® following viewing of car accident videos reduced intrusive imagery symptoms in healthy adults[4]

Memory for peripheral visual details reduced for negative tone, high arousal images compared to neutral tone, low arousal[5]

STIMULI

- 40 full-color images from the International Affective Picture System (IAPS)[6]
  - **20 Negative** (avg. valence = 2.63, avg. arousal = 6.04)
  - **20 Neutral** (avg. valence = 5.14, avg. arousal = 3.64)
- Images cropped as needed to identify area of central focus & at least one peripheral detail
- **Negative** images depicted: car wrecks, human violence, animal abuse, assaults with & without weapons, etc.
- **Neutral** images depicted: indoor/outdoor portraits, vehicles, urban scenes, etc.
- 4 predefined presentation sequences

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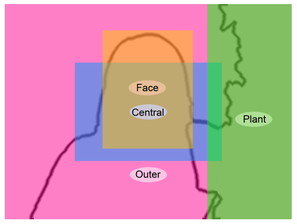
Method

Surveys

- *N* = 39 (21 female, mean 23 years)
- *Mental health screening form*: exclude history of mental illness or trauma
- VVIQ-2[7]: voluntary mental imagery vividness
- Post-task survey: category familiarity & pleasantness ratings
- Intrusive Imagery survey: frequency & content of involuntary imagery reported at 7-day follow-up

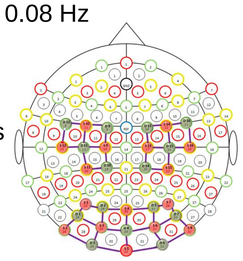
Eye Tracking

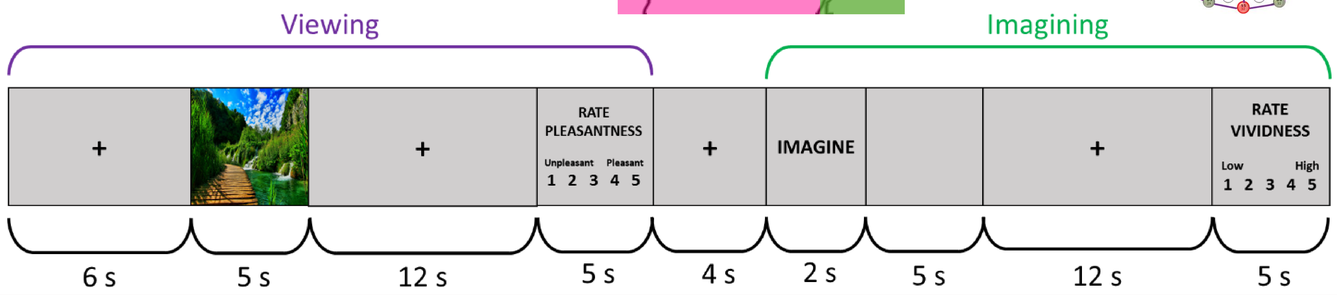
- Tobii X2-60 infrared eye tracker (60 Hz)
- Final *N* = 37 (21 female)
- Pleasantness & vividness ratings determined by longest fixation duration
- Central (25%) & Outer AOIs (both tasks)
- Item AOIs defined for each image (Viewing only)



fNIRS (functional near-infrared spectroscopy)

- NIRScout NIRx (760, 850 nm; 3.91 Hz)
- Final *N* = 24 (11 female)
- 42 channels (16 motor, 16 occipital)
- BPF = 0.015 & 0.08 Hz
- Mean OxyHb per channel collapsed over 6 s pre-stimulus & 12 s post-stimulus





Results

Surveys

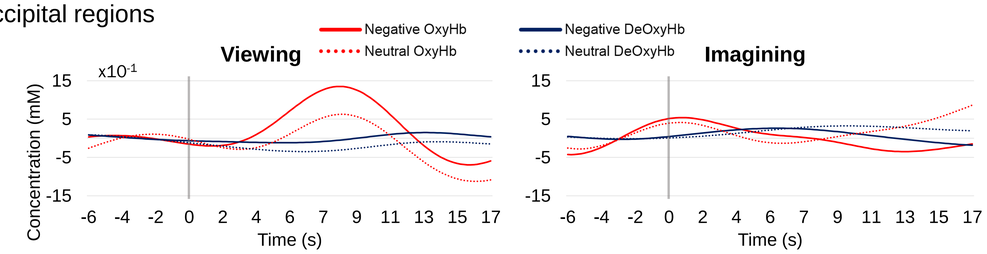
- VVIQ-2: Moderate mean vividness (~75 ± 19.75 pts)
  - Significant predictor of vividness during Imagining trials
- Post-Task Survey: Negative less familiar, less pleasant than Neutral
  - Responses comparable to IAPS valence ratings
- Intrusive Imagery Survey: 31 responses
  - *8 indicated 1 or more involuntary recall events*
  - Not significantly associated with VVIQ-2 score

fNIRS

- No main effect of task, vividness, or familiarity on mean OxyHb
  - *Interactions between task, valence, vividness, familiarity & intrusive imagery*
- Significant effect of motor vs. occipital regions
- Full time course HDR suggests similar response for valence within tasks
  - *Greater amplitude, longer latency to peak during Viewing*

Eye Tracking

- *Central AOI – Outer AOI = central bias difference score*
- Total Fixations: Significant main effect of task on total fixation count & fixation duration difference scores
- First Fixations: Significant main effect of task on first fixation AOI count & fixation duration difference scores
  - First fixation latency & duration interacted with vividness, familiarity, & valence
  - *Shorter latency & longer duration difference score predicted involuntary imagery*
- Item AOIs: No significant difference in total fixation count or duration to Central Item AOIs related to image valence
- Overall, no main effect of valence
  - *First fixations revealed more interactions with cognitive factors*



Discussion

Narrow focus of eye gaze to emotional film clips associated with poorer object memory upon immediate recall[8]

- Old/new test for static scenes revealed enhanced scene gist for emotional scenes
- *Suggests stronger holistic encoding weakly correlated with eye movements*

Sensory-bound representations more susceptible to intrusive imagery than contextualized representations[9]

- Distinct neural networks for each type
- Top-down activation of voluntary imagery vs. bottom-up activation by situational cues during intrusive imagery
- *Inflexible sensory-bound representations more susceptible to flashback*

Emotional stimuli may moderate holistic gist encoding

- Amygdala activity altered to recruit networks for sensory-bound representations, triggered by situational cues
- Scene gist poorly reflected by eye movements

Future work: stimulus arousal, first fixations to Item AOIs, comparison to clinical sample

References

[1] Loftus, Loftus, & Messo (1987). Some facts about “Weapon Focus.” *Law and Human Behavior*, 11(1), 55–62.

[2] Flowe, Hope, & Hillstrom (2013). Oculomotor examination of the Weapon Focus Effect: Does a gun automatically engage visual attention?: *PLoS One*, 8(12).

[3] Laor et al. (1999). Image control and symptom expression in posttraumatic stress disorder. *J. of Nervous and Mental Disease*, 187(11), 673–679.

[4] Holmes et al. (2010). Key steps in developing a cognitive vaccine against traumatic flashbacks: Visuospatial Tetris versus Verbal Pub Quiz. *PLoS One*, 5(11).

[5] Yegiyan & Lang (2010). Processing central and peripheral detail: how content arousal and emotional tone influence encoding. *Media Psychology*, 13(1), 77–99.

[6] Lang, Bradley, & Cuthbert (1997). International affective picture system (IAPS): Technical manual and affective ratings.*The Center for Research in Psychophysiology, Univ. of Florida.*

[7] Marks, D. F. (1995). New directions for mental imagery research. *Journal of Mental Imagery*, 19(3–4), 153–167.

[8] Subramanian et al. (2014). Emotion modulates eye movement patterns and subsequent memory for the gist and details of movie scenes. *Journal of Vision*, 14(3), 31–31.

[9] Brewin et al. (2010). Intrusive images in psychological disorders: Characteristics, neural mechanisms, and treatment implications. *Psychological Review*, 117(1), 210–232.

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