Emotion & Memory

July 13, 2016
Stephanie Gagnon
Announcements

- **Midterm** is Wednesday, July 20th in class
  - Will cover material up to (and including) Wednesday, July 13
  - Will cover any material discussed in lecture and assigned journal articles *except* ‘neuroanatomy primer’ section
- Karen is out of town but can be reached by email
Homework

- **Memory in Action: Technology and memory brainstorm** due 8 PM on Sunday, July 17th
  - [http://web.stanford.edu/class/psych136s/memoryinaction/index.html#brainstorm-tech](http://web.stanford.edu/class/psych136s/memoryinaction/index.html#brainstorm-tech)
  - Pay attention to how you are using technology and how you think this might affect your episodic memory, and answer the response questions in your MiA document

  - [http://web.stanford.edu/class/psych136s/reading/index.html#henkel](http://web.stanford.edu/class/psych136s/reading/index.html#henkel)
  - Read article and answer the response questions in your SJR document
Last time

- **Factors affecting retrieval success.** Cues, external context, internal state, and mood

- **Subsequent memory design.** Increased activity in MTL, top-down attention, and content regions during encoding is predictive of later remembering

- **Item vs. associative memory.** MTL cortex vs. hippocampus engagement during encoding

- **Neural basis of episodic retrieval.** Hippocampal pattern completion, hippocampal-cortical interactions, cortical reinstatement

- **Retrograde amnesia.** Damage to the MTL (patient E.P.), temporally-graded disruption of declarative memory, Ribot gradient

- **What is memory consolidation?** Standard consolidation theory, sleep-dependent replay, multiple trace theory
Emotion & memory

Transient memory
- Sensory
- Working (short-term)

Long-term memory
- Declarative
  - Episodic
  - Semantic
- Non-declarative
  - Conditioning
  - Skill learning
  - Priming
Emotional memories

An impression may be so exciting emotionally as almost to leave a scar upon the cerebral tissues.

William James (1890)
This time

- Defining emotion
- Flashbulb memories
- Why does emotion enhance memory?
- Real world examples
This time

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Defining emotion

Ekman’s 6 “basic” emotions

- Happy
- Sad
- Fear
- Anger
- Surprise
- Disgust

Affective circumplex

- **Valence** (positive, negative)
- **Arousal** (high, low)
Defining emotion

Schachter & Singer’s Two-Factor Theory of emotion

- Emotional stimulus
- Bodily response (arousal)
- Cognitive appraisal
- Conscious emotional feeling
This time

- Defining emotion
- **Flashbulb memories**
- Why does emotion enhance memory?
- Real world examples
Flashbulb memories

Extremely vivid, long-lasting memories for unexpected, emotionally laden, and consequential events

Talarico & Rubin (2003)

- Hypothesis
- Methods
- Results
- Strengths/weaknesses

- Hypothesis?

- **Hypothesis**: Compared with everyday memories from the same time, are flashbulb memories really more accurate/consistent over time?

- **Hypothesis:** Compared with everyday memories from the same time, are flashbulb memories really more accurate/consistent over time? Over time, do participants have a greater subjective sense of recollection, vividness, and belief in accuracy for emotional flashbulb memories?

- Method?

• **Method**: subjects were contacted the morning after 9/11 and asked a series of open-ended (objective) and rating-scale (subjective) questions about their memory of the 9/11 attacks and another everyday event; they were then brought back to complete the same task either 7, 42, or 224 days later.
Subjective vividness, accuracy, and feelings of “time traveling” or recollection declined over time for everyday memories, but did not decline for flashbulb memories; however, objective memory consistency decreased over time for both types of memories.
Memory for 9/11

Amount of Rehearsal

Relative amount of rehearsal (1-7 scale)

Flashbulb | Everyday
---|---
6 | 3
4.5 | 1.5
3 | 0

Ratings of emotional intensity, emotional strength/consistency, visceral response

Flashbulb | Everyday
---|---
PTSD Symptoms

Predicting PTSD symptoms

Initial visceral response

Talarico & Rubin (2003)
Memory for 9/11

• Were these findings surprising to you?
• What do you think were the main strengths of this experiment?
• What do you think were the main weaknesses?
• How do you think memory for the “everyday” events used in this study compare to other everyday events? How do you think the initial recall event (Day 1) might have played a role here?
• How do you think memory for consequential public events like 9/11 compare to memory for private emotional events?
Emotional memory in the lab

- Manipulate **content of stimuli** to be remembered
  - IAPS images, words

- Manipulate **emotional state** of the participants
  - Film clips/music/emotional words or pictures, reflect on emotional situations, money, loud random noises, difficult cognitive task, prepare/give a public speech, put arm in ice water, mild shocks
Test you knowledge!

Based on the Schachter & Singer’s Two-Factor theory of emotion, what two factors are necessary to cause conscious emotional feelings?
Test you knowledge!

- Based on the Schachter & Singer’s Two-Factor theory of emotion, what two factors are necessary to cause conscious emotional feelings?
Measuring emotion

Bodily response (arousal)
- Electrodermal activity (EDA): sweating/skin conductance
- Heart rate
- Pupillometry
- Saliva (cortisol, alpha-amylase)
- Eye-blink startle

Cognitive appraisal

Anxiety Rating Scale

- Balanced mood
- Slight fear and worry
- Mild fear and worry
- Moderate worry, physical agitation
- Strong agitation, pacing, can't sit still
- Out-of-control behavior, self-harm

negative ←-----► neutral ←-----► positive
This time

- Defining emotion
- Flashbulb memories
- **Why does emotion enhance memory?**
- Real world examples
When completing the Emotion and memory demo, what are some factors that might have affected (enhanced/impaired) your memory for the different types of words (positive, negative, neutral)? Try to think of factors you’ve learned about in the encoding/retrieval lectures!
Your data!
Mood-congruent retrieval

Teasdale & Russell, 1983

- Cue–dependent nature of memory has important implications for mental health.
- Internal state biases retrieval toward mood–congruent experiences, which can create “snowball” effects.
Why does emotion enhance memory?

- Capture of attention
- Physiological arousal
- Increased amygdala activity
Why does emotion enhance memory?

- Capture of attention
- Physiological arousal
- Increased amygdala activity
The attention which we lend to an experience is proportional to its vivid or interesting character; and it is a notorious fact that what interests us most vividly at the time is, other things equal, what we remember best. An impression may be so exciting emotionally as almost to leave a scar upon the cerebral tissues.

William James (1890)
Capture of attention

- **Affective primacy hypothesis**: emotional stimuli capture attention via bottom-up mechanisms; more difficult to attend to non-emotional stimuli
Capture of attention

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Emotional stroop task:

- RABIES
- BROOM
- STOVE
- CANCER
- SOCK
- SUICIDE

\[ \text{green!} \quad \text{…blue} \]

*e.g.*, McKenna & Sharma (1995)
Capture of attention

- **Affective primacy hypothesis**: emotional stimuli capture attention via bottom-up mechanisms; more difficult to attend to non-emotional stimuli

Weapon focus effect:

Loftus et al. 1987; Mitchell et al. 1998
Capture of attention

• **Affective primacy hypothesis:** emotional stimuli capture attention via bottom-up mechanisms; more difficult to attend to non-emotional stimuli

Emotional attentional blink:

McHugo, 2013; modified from Most et al. 2005
Capture of attention

- **Affective primacy hypothesis**: emotional stimuli capture attention via bottom-up mechanisms; more difficult to attend to non-emotional stimuli

Dot probe task

- **respond 'left' quickly**
- **respond 'left' slowly**

Modified from Lipp & Derakshan (2005)
Capture of attention

- Free recall & emotional words

Encoding:

Retrieval:

rabies.....barrel.....mother.....baby......
Capture of attention

- Free recall & emotional words

During free recall, you’re more likely to:

1. recall more emotional than neutral words
2. make transitions between emotional items, which suggests that there is “emotional clustering” happening at encoding/retrieval

Long, Danoff, & Kahana (2015)
Why does emotion enhance memory?

- Capture of attention
- Physiological arousal
- Increased amygdala activity
Physiological arousal

- **Hormone release**

  - Catecholamines (e.g., adrenaline)
  - Glucocorticoids (cortisol)

  ![Diagram showing the physiological arousal process involving Stress, Corticosterone, and its effects on rapid and slow changes through different levels (Molecular, Cellular, Behavioural).](image)

  de Kloet et al. 2005
Physiological arousal

- Hormone release influences neural activity

Schwabe et al. (2012)
Physiological arousal

- Yerkes-Dodson law

Adapted from Arnsten, 2009
Physiological arousal & cortisol

- Moderate levels of stress before encoding can enhance memory, particularly for emotionally arousing materials.
Test your knowledge!

• Briefly describe standard consolidation theory
Test your knowledge!

- Briefly describe standard consolidation theory
Consolidation

- **Systems consolidation**: hippocampus-dependent memories become independent of the hippocampus over a span of weeks to years.

- **Synaptic consolidation**: when neurons fire together during learning, connections between them are strengthened; if they are “tagged”, then these connections are stabilized during a consolidation period shortly (minutes to hours) after learning.

Dudai (2004)
Physiological arousal

- Moderate levels of stress during synaptic consolidation can enhance memory, particularly for emotionally arousing materials

Cahill et al. (2003)
Physiological arousal

- Moderate levels of stress during synaptic consolidation can enhance memory, particularly for emotionally arousing materials

Cahill et al. (2003)
Physiological arousal

- Moderate levels of stress during synaptic consolidation can enhance memory, but especially low or high levels can **impair** memory

Adreano & Cahill (2006)
Why does emotion enhance memory?

- Capture of attention
- Physiological arousal
- Increased amygdala activity
The amygdala
Increased amygdala activity

- Greater activity in the amygdala and MTL during successful encoding of emotional > neutral stimuli

Murty et al. 2010
Increased amygdala activity

- Greater activity in the amygdala during successful encoding of emotional film clips

Cahill et al. 1996
Retrieval of emotional memories

- Greater activity in the amygdala during vivid remembering of emotional (negative, highly arousing) images

**Remember**: Evokes a specific memory for the episodic context in which the stimulus was experienced, such as a thought, feeling or sensory detail

**Know**: Stimulus is 'known' to have been experienced earlier but does not bring to mind a recollection of a specific episode

Adapted from Sharot et al. (2004)
Monetary incentives enhance subsequent memory for material tested 24 hours later; this enhancement is supported by encoding-related activity in the ventral tegmental area (VTA), nucleus accumbens, and hippocampus.

Adapted from Shohamy & Adcock 2010; Adcock et al. 2006
Test your knowledge!

- Identify one piece of experimental evidence showing that emotional stimuli capture attention
This time

• Defining emotion

• Flashbulb memories

• Why does emotion enhance memory?

• Real world examples
Posttraumatic stress disorder

For four nights after the accident, I relive what I cannot remember by day — the moment of impact, the blasting jolt to my body, the roar of collapsing metal and splitting glass in my ears — and I wake with a scream in my throat, my heart racing, my limbs stiff with terror. It feels as if the collision were happening again.

- Siri Hustvedt

http://opinionator.blogs.nytimes.com/2012/02/18/reliving-the-crash/?_r=0
Posttraumatic stress disorder

- Psychological trauma (rape, physical assaults, torture, motor vehicle accidents) can lead to post traumatic stress disorder (PTSD); this is often characterized by repeated “reliving” of the traumatic experience.
Posttraumatic stress disorder

PTSD patients have impaired recognition memory than combat-veterans without PTSD and controls.

PTSD patients show increased amygdala activity to fearful vs. happy faces.

PTSD patients have smaller hippocampal volumes than control subjects.

Yehuda et al. (2005); Shin et al. (2005); Bremner (2007)
Changing memories

https://www.youtube.com/watch?v=rb9a00bXf-U
Changing memories

- **Reconsolidation**: memories that are reactivated may become unstable and susceptible to change for a short period of time, before they are reconsolidated

Nader & Hardt (2009)
Brainstorm

- How might reconsolidation play a roll in the accuracy of flashbulb memories over time?

Nader & Hardt (2009)
Changing memories

Day 1

propranolol

placebo

1 week later

Brunet et al. (2008)
Reduced arousal (via propranolol) during reconsolidation of a traumatic event reduced emotional responses during retrieval of the event 24 hours later.

Brunet et al. (2008)
Eternal Sunshine of the Spotless Rat

What is a memory? Science writer Jonah Lehrer tells us it's a physical thing in the brain... not some ephemeral flash. It's a concrete thing made of matter. And NYU neuroscientist Joe LeDoux, who studies fear memories in rats, tells us how with a one shock, one tone, and one drug injection, you can bust up this piece of matter, and prevent a rat from every making a memory. LeDoux's research goes sci-fi, when he and his colleague Karim Nader start trying to erase memories. And Nader applies this research to humans suffering from PTSD.

This time

- **Defining emotion.** Basic emotions, valence, arousal, and the two-factor theory of emotion

- **Flashbulb memories.** Consistency vs. subjective sense of vividness, accuracy over time

- **Why does emotion enhance memory?** Capture of attention, physiological arousal, amygdala activity, motivated memory

- **Real world examples.** Post traumatic stress disorder, updating memories through reconsolidation
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• Reading Response: Henkel (2014) due 11:30 AM on Monday, July 18
  • http://web.stanford.edu/class/psych136s/reading/index.html#henkel
  • Read article and answer the response questions in your SJR document
Questions?