PSYC 365 Class 14:
Emotion, motivation, and attention

The week ahead

- Today:
  - Motivation, emotion and attention (Pt 1)
  - Assignments
    - Inman et al., 2023
- Today: DEADLINE to submit MCQ for participation grade!
- Thursday
  - Review
- Tuesday, March 11th
  - Midterm. 1 SAQ, 35 MCQ

Learning Objectives: Motivated Attention (Classes 15 &17)

- Describe four evolutionarily conserved basic emotional/motivational systems
- Explain ways in which amygdala and mid-brain dopamine systems play a role guiding *motivated attention*
- Evaluate factors that influence individual differences in vulnerability to anxiety, addiction and depression

We've been talking about top-down and bottom-up attention. But as I'm sure you've noticed, there are things that guide attention that don't fit into either category - that aren't related to the short-term conscious goals of a task you're performing, but also aren't related to the physical features of an object. In these two classes we're going to talk about two of those things.--motivation and emotion.

Motivation and Emotion: Definitions

- Motivation: The impulse to approach/avoid something that's rewarding or punishing
  - About the urge toward action
- Emotion: The physiological sensations of emotional arousal and subjective feelings that go with them
  - About the subjective experience

Basic brain systems for motivation and emotion

1. Are circuits for responding to major life-challenging events
2. Organize behavioural responses
3. Exchange information with fronto-parietal systems important for high-order conscious cognition
4. **Change sensitivities of sensory systems relevant for dealing with those events**

Here is Panksepp's view of the "gold standard" of what's required for a brain circuit to count as a basic emotional brain circuit. [1] **1**. I'm sure you can think of examples of major life events: Somebody threatens to stop you from getting something you need. Somebody you love dies. Something threatens to kill you. Responses to such events involve subcortical circuits centered on the brainstem, amygdala and basal ganglia. And the basic brain systems for emotion are conserved across many different species – especially mammals. [2]. **2** Something enrages you run out to change it. You lose someone you love you withdraw and cry out for social comfort. For every reaction there's an action. These circuits also exchange a lot of information with our various types of cortex and the various things they do. They [3] **3**....In our case quite a lot of planning and remembering and ruminating etc. [4] **4**. This is going to be our our focus because we are talking about emotional guidance of attention -- once again using the specific example of visual attention, but the same could go for auditory attention etc. We talked about how the DAN influences or "modulates" activity in the visual cortex. Well these emotional circuits do the same thing that DAN does in tuning the sensory cortices to what is motivationally or emotionally relevant. Panksepp calls the best-understood, most reliable circuits Grade A Blue Ribbon emotional systems.

Grade A Blue-ribbon emotional systems

Approach!

Seeking Reward!

Panic: Loss of social reward

Withdraw/ approach

Rage: Thwarted Goals

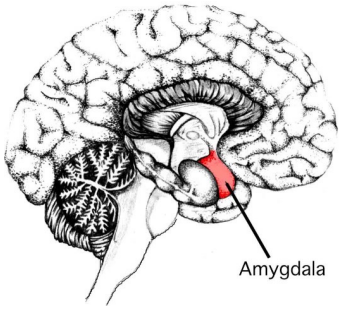
Approach!

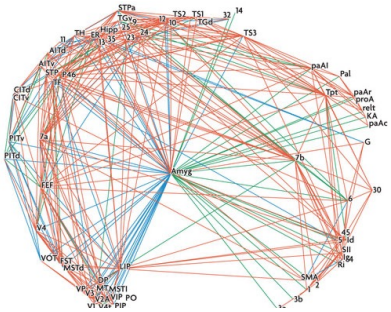
Fearing Punishment!

Avoid!

Amygdala: hub for tagging emotional/motivational relevance

What is important and what is to be done about it?





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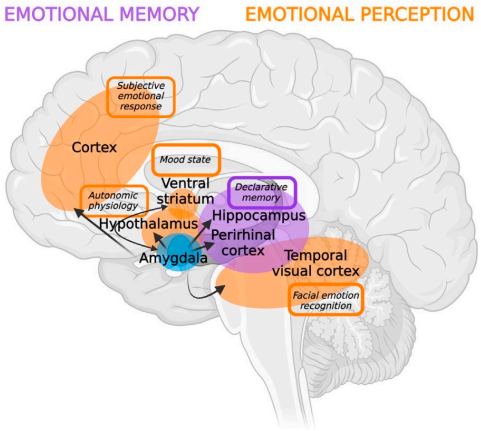
As the Inman paper you were assigned stresses, the amygdala is hooked up to a huge number of other brain regions.. That means it's a hub, or particularly important connective node in the networks. It plays a key role in tagging **what's biologically important and guiding attention and memory to it**. What's biologically relevant grabs your attention because it's relevant to your well being Is that a snake in the grass? A delicious chocolate cake in a shop window? It routes information to other nodes in the networks saying: See it clearly! Pay attention to it! Act appropriately! Remember where it is!.. [1] In general we can say the amygdala has a key role in solving the following problem:

The next 3 slides are based on the Inman paper

- There is no lecture for the material in these slides – you should be able to find the relevant information for yourselves from the paper.
- We won't give you the answers, but we encourage you to discuss it with each other on Piazza!

Multifaceted influence of amygdalae on behavior



You should know the key regions from this figure that are key nodes in networks the amygdala participates in for its functions in emotional perception and memory.

How does the amygdala shape human behaviour?

Exercise your paper reading muscles and answer the following questions about the Inman et al. paper:

1. What amygdala functions have been demonstrated by case studies from the last 3 decades?
2. What is unique about the structure of the amygdala and what does that mean for its multiple functions?

How does the amygdala shape human behaviour?

Exercise your paper reading muscles and answer the following questions about the Inman et al. paper:

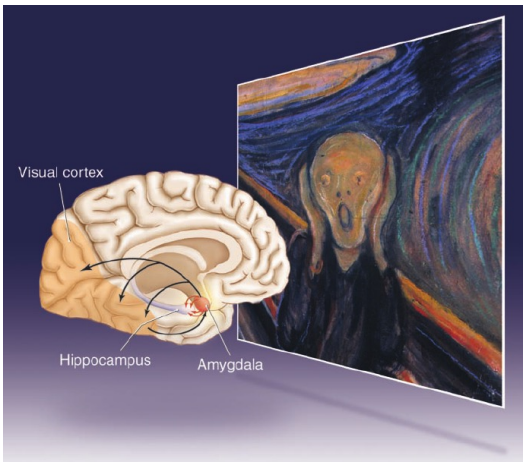
3. How do the authors summarize the role of the amygdala in present perceptions?
    3. List findings from lesion and stimulation studies they use to support this claim.
4. How do the authors describe the role of the amygdala in prioritizing certain memories?
    3. List findings they use to support this claim
5. How do the authors claim that the amygdala's role in perception and memory reflects its unique structure?

Amygdala

It has been proposed that, altogether, the amygdala nuclei solve the following problem:

- How can a limited-capacity information processing system that receives a constant stream of diverse inputs selectively process those inputs that are the most relevant to the goals of the animal?

Amygdala *modulates* visual cortex



You've seen this image before when I introduced the Harada paper. To review, numerous brain imaging studies in humans have found amygdala activity and visual cortex activity to be greater for emotionally arousing than for more humdrum images. It has links to all areas of ventral visual stream because it sends information to every region of the ventral visual stream. Just like DAN and SAN!!

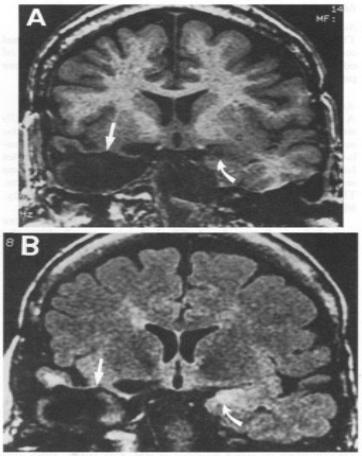
Attentional Bias: Sifting the significant from the mundane

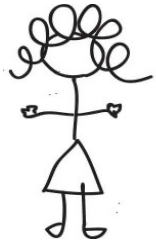
- When emotionally or motivationally relevant information captures attention more readily than neutral information
- *Emotionally Salient:* Pops out because of emotional relevance or meaning

An attentional bias is…. [1] Again, the amygdala is particularly important in tuning attention to what is emotionally relevant. WHAT is more relevant can differ between people - the Inman talks about a bias towards negative information in depression for example. Some categories of thing are almost universally relevant to all people – like bears, snakes, food, attractive people. We say that they are **Emotionally salient.** [2] This means they capture attention – something stands out from its surroundings because of its emotional relevance. It grabs attention. And that's emotional biasing of attention.

Emotional relevance guides attention

The Role of Amygdala in Emotional Attention: S.P.





S.P.

- Bilateral amygdala lesions from mid-life (epilepsy/surgery)
- Studied by Anderson & Phelps

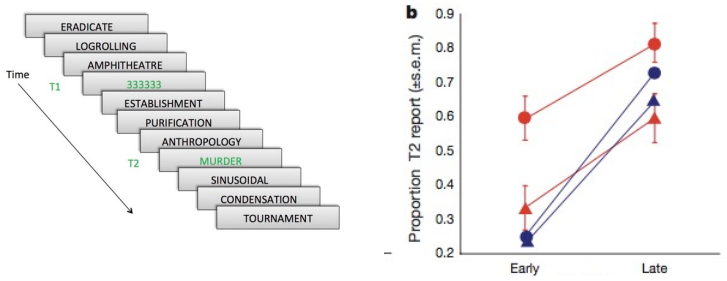
We first learned about the role of the amygdala in emotionally biased attention from the study of a patient called SP. You read about SM in the Inman paper who lost her amygdalae early in chiidhood. SP lost hers later in life and the effects are somewhat different. SP had amygdala lesions on both sides from severe epilepsy – her right amygdala was surgically removed in mid life and her left was badly damaged by seizures. Here is a description of SP: A "funny," and "likeable" woman, divorced with grown children, with an average IQ, a high school degree and some college. She ran a successful business before her epilepsy got too severe. After surgery she no longer suffered from seizures and began working again part time. Her basic memory and intelligence are in the normal range. In her spare time she enjoys painting and writing poetry. After her surgery she participated in many studies by researchers Liz Phelps and Adam Anderson. One thing they studied was how her lesions affected the way emotion guided attention. They did that using a version of a task called an attentional blink task. I'm now going to show you what an attentional blink task looks like.

Testing Attention with the Attentional Blink

Did you see the C? Often you won't. An attentional "blink" is when you fail to see a second target stimulus in a stream of stimuli – in this case a letter in a stream of letters – when it comes too soon (within half a second) of a first target stimulus. And by target stimulus I mean that you are told to remember it. There are a lot of different theories about why this should be but most propose that in some way your resources are still tied up in processing the first stimulus, and those resources don't become available to process the second until the first is fully processed– which takes about half a second – so it's much harder for the second target to rach awareness. So it's as if the mind blinks.

SP: Impaired Emotional Attention

- Attentional Blink: Reduced ability to report T2 when it comes soon after T1
- Emotional Sparing: Reduced attentional blink when T2 is high in emotional arousal (Anderson, 2005). A measure of attentional bias.



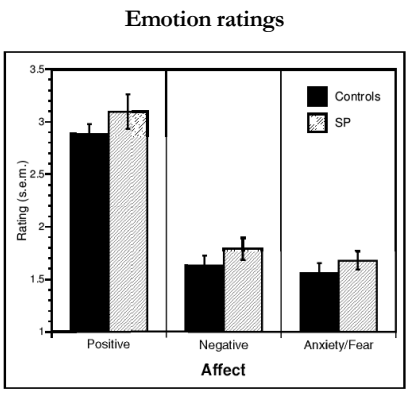
The amygdala influences selective attention for emotional relevance

So an attentional blink is ..... In this study they used a version of the task where every trial was a series of words instead of letters as in the example you just saw. The first target, known as T1, was a series of numerals in green and the second target was a word in green, known as T2 and it could be either neutral or emotionally arousing (good or bad). These targets were embedded in longer words, known as distractor words which were in black, so the targets were harder to see. Each target and distractor word was seen for a 10th of a second. The number of distractor words that came in between the two targets was manipulated so that the T2 words either came very soon (within 500 ms) after T1, so that you would expect an attentional blink with reduced ability to perceive it, or longer than 500 ms after T1, so you would not expect an attentional blink. Participants had to report both targets at the end of each trial. [1] Let's look at the data. On the Y axis are the proportion of T2 -- that's the second target -- words that they got right. And on the x axis is how soon after T1 T2 was presented. Early is less than 500 ms, and Late is more than 500 ms. Blue lines show data from SP and red from a group of control participants with no amygdala damage. Circles indicate that the T2 words were emotionally arousing Triangles indicate that T2 words were neutral. Let's look at the controls, in red, first. For the early trials accuracy for neutral words was only about 30%. That's an attentional blink! but

for emotional words it's much better, around 60%. So there is still an attentional blink but not as big a one. This phenomenon is called emotional sparing [2]....One way of thinking about emotional sparing is that you have an emotional attentional set for guiding attention to things that are emotionally relevant. If we look at the control data for late trials their accuracy is much better, though there's still a difference between accuracy for emotional and neutral words. Now let's look at SP's data. For early trials accuracy is terrible -- a little over 20% -- a big blink and no difference between emotional and neutral. So no emotional sparing there. As with the controls she is showing way better accuracy for late trials, but again no difference between emotional and neutral. So clearly SP does not have this superpower for detecting emotionally relevant words that the rest of us do. This was true for both positive words and negative words. To rule out the possibility that S. P. was just poor at perception in general, the visual similarity of targets and distractors was manipulated, so that the targets would stand out from distractors to a greater or lesser degree. **Q: What kind of attentional process does manipulating visual similarity get at? (bottom up) What attentional network is responsible? (VAN). Like controls, S. P. showed AB sparing for words that were visually easier to perceive -- in contrast** to impaired AB sparing for emotional words**. The conclusion was that [3] the amygdala influences selective attention for emotional relevance but not perceptual salience.**

In Contrast: Intact Emotional Experience

- SP and controls were asked to rate emotional state over 30 days
- No difference in positive or negative emotional experience



Amygdala necessary for emotionally-guided attention, not for feeling emotion!

AB sparing also shaped by experience

- Amygdala key for "emotional sparing"
- Survivors of a near-plane crash are more likely to see related words
- Soldiers with PTSD are more likely to perceive combat related words, less likely to rapidly regulate fear system response

To summarize [1]… [2]. My supervisor did astudy where we used an attentional blink task with people who had survived a near plane crash. On a flight from Toronto to Portugal the plane ran out of fuel and the participants were sure they were about to die. At the last minute, because the pilot had been a drug runner, he was able to land the plane on a tiny runway at an airforce base in the Azores. We gave passengers and controls an attentional blink task with words that were related to the experience and neutral words as T2 targets and the passengers showed blink sparing for those words and controls did not. We also did a study using combat related words with soldiers with and without PTSD and civilian controls. [3] We also did brain imaging with MEG and found that, in PTSD, combat words they were able to identify cause the visual cortex to fire up for a period of time.

Fear System

Emotions

- Anxiety
- Alarm
- Foreboding

Cognition/Behaviour

- Greater Attention
- Greater Memory
- Freeze fight or flee

Now we're going to talk about the role of anxiety, threat and attention. So let's quickly review the fear system. What is the difference between fear and anxiety? Fear happens when you face an identiable threat in the near future. It comes and goes. Anxiety is more about threatening things that could happen over time. It's the fear system in overdrive - so that it doesn't shut down. We've talked about having limited attentional resources. And we have limited physical resources too. In the presence of strong threat we pull them all together and use them with all our might to minimize the probability of body destruction! The amygdala sends signals to your autonomic nervous system (ANS), which then has a wide range of effects. Itsends signals to the hypothalamus, the ANS kicks in, and suddenly, your heart rate increases, your blood pressure goes up, your breathing gets quicker, and stress hormones such as adrenaline and cortisol are released. The blood flows away from the heart and out towards the extremities, preparing the arms and legs for action. Anxiety also activates the stress response, although to a lesser degree, even when there isn't a threat right in our face. But if we do this too much, everyday, when it's not required then it can be very hard on both our physical and mental health. Chronic stress can increase inflammation, which is associated with all kinds of diseases. One symptom of this system in constant overdrive is a bias in attention to potentially threatening

aspects of the world. [1] . Here is something that could either be a stick or a snake. And when in doubt – snake or stick — anxiety sees the snake.

Anxiety

What does it feel like?

I think this video resonates for a lot of us. We seem to be in the wave of an epidemic of anxiety and depression. What does this mean for our attention?

Anxiety: Attentional Bias for Threat

- Amgydala more sensitive to threat than reward
- Leads to elevated physiological response, sensory processing, memory, rumination
- Attention is captured by threatening stimuli
- Capture followed by avoidance

Now I'm going to show a photo and I want you to notice where your attention goes first, and then where it goes after that. [1] Who saw the smiling woman first? What about the woman in the middle with the strange expression? The glass of wine? And the angry dude? Avoidance is flight behaviour. In people who are anxious [2]...This in turn [3]... In particular [3]... These attentional biases set up feedback loops and can both cause and maintain clinical levels of anxiety. You see the threatening things, your amygdala ramps up your other systems, and you are more likely to remember and ruminate about them, which tunes your attentional system more towards them in the future. There is also evidence that in anxiety that initial capture is followed by a disengagement of attention -- you avoid attending the thing you find threatening [4]. You also tend to avoid situations you perceive as threatening so in many instances there is less opportunity to learn that they are actually not threatening – they are pretty safe. If you just see threat and run you never take the sting out of the situation.

Questions for you

- What do you think happens with attention when you have a traumatic experience?
- What are some ways of reducing feedback loops set up by attentional biases?

Summary

- Grade A Blue Ribbon emotional systems evolutionarily conserved
- Amygdala: "tagging" emotional salience and routing information to other brain regions to enhance attention (& learning & memory)
- Loss of amygdala can result in impaired attention to what's emotionally relevant
- Amygdala is key for tuning attention to what is relevant in the world based on experience

Summary 2

- In anxiety and PTSD attentional bias to threat is extreme, and amygdala systems can go into overdrive and hurt more than help
- Result: Seeing threat everywhere at the expense of safety and reward!
  - Attention is limited after all

Discussion time!

Consider the TED talk by Anil Seth, "Your brain hallucinates your conscious reality." Explain his take that hallucination is uncontrolled perception while perception is controlled hallucination. How does this relate to what we have learned about the visual system, object recognition, and other modes of perception?

Discussion time!

You mentioned when talking about the Egner et al. paper that surprise has twice the impact then expectation on FFA activation, but do we know if this is always the case? Would surprise always be more impactful than expectation, or in something like a new situation where we don't have any expectations does this interaction change?

Also do we know if this ratio is held across brain regions where predictive coding is likely used, for example in other modalities like hearing?

Discussion time!

Since the predictive coding model relies on updated expectations of what is being perceived, how does the brain recognize objects of completely unfamiliar scenes or objects that do not fit into any existing categories? Does it create a new category or attempt to fit it into a pre-existing one? How is this process altered in individuals who have autism?

Discussion time!

I was once kayaking in a lake and saw a large figure in the not-too-far distance, but could not identify what it was. I continued staring at it and squinting and moving my head around to get a better look so that I could identify the object and I could feel the prediction programming in my brain working hard, but never was able to identify it. What is interesting about this experience is that I had so much discomfort in not knowing what it was. To this day I get anxiety thinking about my inability to identify this object despite perceiving it. **I am curious what you think might be going on chemically and functionally in one's brain when they sense this emotional and physiological unease from a failure to match up bottom-up information to top-down schemas of the world, and how this phenomenon might be explained psychologically?**

Next time…

- Midterm 2 review session with Ava Momeni and myself