Neuroscience Advances for Improving Anxiety Therapies
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My Interest:
Interested in affective neuroscience = the study of emotional processes in the brain
Integrated this knowledge into a model (Hierarchical Levels of Neural Processing, HLNP) that explains many of the problems that therapists address and provides a practical way of applying this knowledge to the treatment of these problems
Anxiety is the emotion that has been most thoroughly studied so far, so I have developed techniques for treating anxiety disorders based on this model.

Studies of anxiety treatments have identified four broad groups of techniques that have been found to be empirically supported:
1. Psychoeducation about what is happening when anxious
2. Calming methods like abdominal breathing to reduce the physiological arousal
3. Self-talk techniques like CBT to revise the cognitive thinking that produces anxiety
4. Exposure methods that behaviorally condition new responses when anxious

Will be introducing you today to three specific applications that take established procedures for treating anxiety and improve them by applying this new knowledge.

Objectives:
1: Outline how to reduce amygdala alarm by explaining its functioning and by using mindful attention to refocus its energy.
2: Describe how to change dysfunctional self-talk using neuroscience challenges that supplement the usual CBT techniques.
3: Explain how to improve exposure techniques by mindfully turning on the extinction circuits instead of trying to turn off the conditioning circuits.
1. Improving the Education about the Panic Process

Objective 1: Outline how to reduce amygdala alarm by explaining its functioning and by using mindful attention to refocus its energy.

Old Explanations of Why People Panic

Most previous explanations relied heavily on the cognitive model of brain functioning

At the top, the mind / cognitive processes made decisions and controlled emotions and behaviors
At the bottom, body / biological processes produced the physiological symptoms
There was murky middle that somehow connected the processes but it was still mysterious

Emotion was conceptualized as a cognitive thought attached to a physiological process

So anxiety was a feeling characterized by symptoms of sympathetic autonomic arousal and cognitive thoughts about fearful dangers that triggered this arousal

Thoughts control feelings, so changing thoughts will change feelings

It was a top-down neurological model: higher level thinking controls lower level reacting

New Neuroscience Explanations of Why People Panic

Neuroscience expands and refines the levels of brain processing

At the top, the higher level is differentiated into two levels of neocortical processing
The murky middle is differentiated into two levels of processing

Above the bottom level of physiological processing (brain stem nuclei), a level of instinctive reflexive processing residing in brain nuclei is recognized
It is sometimes referred to as the reptilian brain
Its nuclei control instinctive survival reactions that provide for individual survival

Above the brain nuclei and below the neocortex is the paleocortical level of processing
It is often referred to as the mammalian brain
It controls emotional functioning that create new decision making processes and new social communication processes that provide for group survival

It creates a bottom-up model: lower level reacting controls higher level thinking.

Anxiety is created and controlled largely at the brain nuclei level by the amygdala
The amygdala’s decisions that are designed to protect the individual from possible danger are creating most of the experiences associated with panic
Understanding its functioning provides a much clearer understanding of what is happening in panic processes and provides a much better base upon which to build therapeutic interventions

Change 1: What Triggers the Fear Process

Old: Cognitive appraisals of danger trigger the process

New: Amygdala detection of possible danger triggers the process

Amygdala comes fully wired about a month before birth with all its response circuits online
Explicit cognitive processes require hippocampal myelination that only starts in second year of life
This nuclei is so crucial for surviving dangers that it is shared by most lower animals

When I want a metaphor for its functioning I will refer to it as lizard or infant responding
It receives information directly from sensory systems before any higher level processing. It receives external info but in a quick and fuzzy form – just the gist of what it is encountering. But it also receives info from internal systems – it monitors heart & breathing rates, etc.

Amygdala is like the brain’s sentry – on guard for any possible danger. It is hard-wired to unconsciously and reflexively trigger its emergency responses. Some stimuli are genetically programmed for their value to a specific species of animal. Rats can recognize cat dander; chickens can recognize hawk silhouettes. Human infants can be triggered by pain, difficulty breathing, loud noises, being dropped, and by anger or anxiety on the faces of people they see. If it detects these dangers, it automatically triggers a whole series of inherited responses. At the body level, it triggers the arousal of the sympathetic autonomic nervous system that enables emergency action by accelerating processes like breathing, heart rate & blood pressure, etc. At the brain level, it triggers the release of neurotransmitters like norepinephrine and dopamine that facilitate a similar acceleration of brain functioning. At the behavioral level, it produces survival responses like freezing and running. These are the responses that people experience when frightened that can now be explained.

In mammals, the amygdala response is fed up to the paleocortex where: it is translated into emotions that are used in mammalian problem solving and it produces the distress cry that is instinctively programmed to communicate to mothers.

Amygdala is a simple, reactive on-switch. It has no capacity to evaluate dangers, it fires to all possible dangers. Amygdala cannot turn itself off – it has no off-switch. In reptiles it can only be turned off by escaping the stimuli that is turning it on (humans also). Mammals have no hard-wired safety switch to turn off their arousal. But they have mammalian solution – fear triggers the distress cry which brings mother and her presence produces calming that can be called the security switch. As mammals mature they can begin to internalize mother’s security which will create a learned off-switch.

**Change 2: What Is the Fear Trigger in Panic**

**Old:** There doesn’t seem to be a trigger in panic – no external stimuli associated.

**New:** Amygdala can learn to unconsciously associate internal stimuli with danger.

Amygdala is where fear conditioning takes place. If amygdala is lesioned, then no fear conditioning, no autonomic arousal, & no feeling of fear. Amygdala learns by unconscious implicit stimuli conditioning – do not have to be conscious to learn. Amygdala can easily learn certain predisposed stimuli – like snakes, insects, blood, etc.

When external sensory stimuli is associated with amygdala arousal, will learn as phobia.

The intensity of the amygdala arousal is taken as the validity of the association. If the arousal is intense, then can have one trial learning – “flashbulb memory.” So it is easy to learn false alarms (no real danger, but intense arousal) – superstititious learning. Since amygdala monitors internal stimuli like heart rate, it can learn to view it as a fear stimuli. Interoceptive stimuli are usually the basis for panic attacks. Once learned, an intense fear conditioning circuit will be remembered for ever.
Change 3: Why Do the Panic Feelings Become So Intense and Uncontrollable

Old: Escalating panic is difficult to explain and difficult to turn off

New: Panic is caused by an escalating feedback cycle
Amygdala is monitoring internal feedback, so it will easily fire to an escalating heart rate
But it fires sympathetic autonomic arousal that further increases heart rate
Instead of reducing the fear stimuli, this actually amplifies it
Vicious feedback cycle is set up that can only be terminated by the higher order safety signal

Not understanding what is happening will further escalate the process
because the amygdala responds to the possibility of danger
So uncertainty and novel stimuli will tend to trigger amygdala arousal

People often naively try to turn off the arousal by saying “Don’t be afraid”
Unfortunately neocortically generated words do not communicate to the amygdala
Does saying this to an infant do any good?
Only the emotional feeling associated with the words communicates to the amygdala
If “don’t be afraid” is communicated will with an angry tone or facial expression
then the negative arousal will actually amplify the process
And only positive calming feelings will activate the security signal

The other problem with “don’t be afraid” is that it implies that being afraid is a problem
A problem is a danger, so the amygdala will alarm

Change 4: Why Does Accepting the Anxiety Make Sense

Old: Accepting is advocated as a pragmatic solution

New: Accepting makes sense given the understanding of the neural circuitry
The explanations above suggest a useful three step strategy

1. Accept the anxiety as an old amygdala alarm
   - Cannot head off the initial amygdala alarm – happens before higher level can respond
   - Can only correct the feedback response
   - So don’t fight the response, since this will only feed it
   - Knowing what is happening removes the sense of uncertainty that could escalate the process
   - Knowing that the amygdala response is only an “old alarm” reminds that it may not be a real danger

2. Thank the amygdala for doing its job
   - Ignoring an emotional circuit will result in it escalating
   - Recognizing that the amygdala has done its job terminates its need to continue
   - Thankfulness is a positive emotion which is calming instead of aggravating
   - Using the mindful approach of treating it as a distracting stimulus that is allowed to pass through

3. I will now use my thinking brain to assess what the problem really is
   - Recognizing that the amygdala cannot reason, so don’t take its feeling as a reality
   - Shift focus to higher level processing which can reason
   - Use mindfulness to keep attention focused on the level that you can control
2. Improving Self-Talk

**Objective 2:** Describe how to change dysfunctional self-talk using neuroscience challenges that supplement the usual CBT techniques.

**Change 1: Does Thinking Causing Feelings?**

**Old:** Classic cognitive model assumed that thinking caused feelings
- So by controlling and changing thinking a person could change and control feelings
- This was a top-down neurological model

**New:** Emotional processes more often create thought processes
- Fear process begins with the amygdala triggering instinctive responses and autonomic arousal and its activation signal is sent up to the paleocortex
- Paleocortex translates activation signal into an emotion that is used for making emotional decisions and responses and sends this emotion up to the neocortex
- Emotional functioning is largely a right hemisphere process that develops most in first years of life
- Toddlers and dogs can make many decisions without the benefit of any higher level verbal processes
- Neocortex adds a verbal interpretation to these lower level responses
- Verbal functioning is largely a left hemisphere process that develops later in childhood
- Gazzinga’s research with split brains showed that the left makes its best guess at what the right is doing
  - Ex: If right waves, then left assumes that saw a friend
  - Read McGilchrist’s *The Master and His Emissary* for a fuller understanding of these processes

In a typical panic attack, the amygdala activation produces an accelerated heart rate that the neocortex naively interprets as a heart attack
- The process is *bottom-up.* Emotional responses are producing thoughts.
- Once a thought has been produced it will be sent back down for an emotional appraisal
  - The thought “I am having a heart attack” will produce a fear response in the paleocortex that will in turn further amplify the amygdala arousal of the cardiac system

So thoughts can produce emotions, and correcting these thoughts does help control the fear
- But the linear assumption that this is how it happens will create problems in trying to do this
- It is actually a circular process and the bottom-up is usually more powerful than the top-down
- However, the top-down process is more easily changed so therapy will usually begin with it
- Self-talk changes are vitally important in directing the development of new emotional responses

**Change 2: Why Do Dysfunctional Thoughts Develop?**

**Old:** CBT identified common cognitive errors but did not explain why developed
- CBT never explicitly explained how distorted thinking developed
  - Since it was a cognitive model, the implicit assumption that most people make is that they were not thinking wisely, i.e., they were thinking stupidly

**New:** Common errors are naïve interpretations of amygdala decision making
- As explained before the amygdala makes decisions which are fed up to the neocortex which then interprets them
  - Since the amygdala makes all-or-none decisions, it is understandable that they would be cognitively interpreted in the same way
The paleocortex makes decisions using emotional processes
These processes are more sophisticated than the amygdala but still not the same as the logical processes of the cortex
For example, competing emotions are compared and the strongest is executed, so emotional reasoning (if it feels right, it is right) would be an easy interpretation to make
There is not time now to explain the emotional decision making processes, but once you understand them you can explain many of the common errors (Handout 2)

When a therapist identifies a common error, it can be explained as decision made by the lower systems when the person was young or so stressed that higher systems were not working
This makes it easier to later challenge and correct the error
The person does not feel like a stupid thinker, just a immature or confused problem solver
Understanding softens the validity that defends a belief and makes it more open to challenges
Seeing the problem as lower level solutions makes it easier to seek higher level solutions

Change 3: How Are Distorted Thoughts Challenged?

Old: CBT challenged the validity of these thoughts with logical experiential analysis
CBT has developed many effective ways to help people challenge their distorted self-talk
Underlying all these methods is a challenge to the cognitive validity of the old belief
Neocortical processes mainly use this validity to compare solutions
Unfortunately paleocortical processes use both validity and valuation to compare solutions
Valuation is measured by the strength of the emotion associated with an option
Emotional processes compare valuations and execute the option with the greatest valuation
So even though old belief can intellectually seem false, it can feel true
CBT solution is to simply keep doing new because valid and let feeling change in time

New: Can also challenge by recognizing the limitations of lower level decision making
When understand emotional problem solving, can challenge its valuation of a response
Emotional processes use implicit memory which is totally past based
Only explicit memory processes can use working memory to envision and use future consequences
Enables therapist to challenge old response’s valuation but asking client:
Would you rather trust your amygdala’s choice with its simplistic solution that traps in past
Or would you rather trust your higher thinking which can imagine new rewards in the future

This is a way to undermine the valuation of the old response that protects its automatic execution
It is also a way to increase the valuation of the new response by using its imagined
Adding emotional reasoning about valuation to the cognitive reasoning about validation increases the effectiveness of challenges of distorted thinking

Change 4: How Are New Thoughts Empowered?

Old: CBT empowers new responses by strengthening their sense of validity
Usual question is how believable is the new belief to you
There is a recognition of how you also feel but it is seen more as the outcome of doing
If you behaviorally do it enough (repetition), then it will eventually change the feeling
New: Besides validity, new responses are mainly empowered by valuation
Cognitive validation will help a new belief become neocortically (intellectually) empowered
But motor responses at the paleocortical level are mainly empowered by emotional valuation
And amygdala responses are only changed by the emotional valuation coming from above

So focus not just on what say in the new self-talk (do want it to be valid, believable)
but just as importantly on the emotion that is expressed with the saying
Useful metaphor: when talking to the amygdala, imagine yourself comforting a frightened child

There are four main emotional signals that produce the fear extinguishing circuit
Security signal – produced by presence of a supportive person who can protect from danger
This is the inherited initial basis for learning this circuit
Safety signal – produced by the awareness that there is little probability of danger
Tolerability signal – produced by confidence that a painful outcome can be endured
Mastery signal – produced by confidence that have the skill to master the danger

The last three are cognitively produced by the three main questions asked by CBT
Safety = what is the likelihood that the feared outcome will actually happen?
Tolerability = what is the worst outcome that would occur if the danger did happen?
Mastery = do you have confidence in your skill to get satisfactorily thru the danger situation?

Mammals produce these signals with emotional valuation processing that does not require words
Therapists promote them by expressing their emotional confidence when they sense aspects
in their clients that indicate that the clients have these capacities
Therapists strength them by focusing clients on being aware of and valuing these emotions
when they experience them in their efforts

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Haven:
3. Exposure Improvements

Objective 3: Explain how to improve exposure techniques by mindfully turning on the extinction circuits instead of trying to turn off the conditioning circuits.

Old Behavioral Overview of Exposure Process
1. Unlearning the association between an anxious stimulus and an anxiety response
2. Reassociating feelings of relaxation and safety with that stimulus

Diagram:

Anxiety response – unlearn association – Stimulus – relearn association – Relaxation response

Anxiety and relaxation are incompatible responses – can only experience one or the other
Equivalent to assuming a single circuit or switch: can only be on or off

New Neuroscience Overview of Exposure Process
There are two circuits: the fear conditioning or on-circuit and the fear extinction or off-circuit.

The fear conditioning circuit does not unlearn its association with the dangerous stimulus.
The fear extinction circuit learns to associate the stimulus with a sense of security, safety, tolerability, or mastery that can gain the capacity to turn off the fear conditioning response.
The safety signal comes from the emotional brain (orbital prefrontal cortex & ventromedial prefrontal cortex) which have the capacity to make a more sophisticated appraisal of the dangers involved with the stimulus.

Safety signal is conditioned to the stimulus in the presence of the fear signal.
As the safety signal becomes emotionally more powerful than the fear signal, then it gains the power to turn off the fear response.

Diagram 3A: Amygdala Circuits for Fear provides a good model for explaining to clients
Diagram 3B: Extinction Study Diagrams provides a more sophisticated model

Change 1: Goal of the Exposure Process

Old: Goal is to feel less anxious by extinguishing the fear conditioning
Focuses on the reduction of anxiety as the outcome indicator.
Assumes that the anxiety will no longer be associated with the stimulus.
Is equivalent to trying to turn off the on-signal.

New: Goal is to feel more safety by learning the fear extinction circuit
Focuses on the increase in the sense of safety as the outcome indicator.
Expects that the anxiety will still be associated with the stimulus.
Is equivalent to trying to turn on the off-signal.
See Diagram 3C: Goal of Exposure
Change 2: Process for Doing the Exposure

**Old:** The amount of repeated behavioral exposure produces the effect
- Does not emphasize the mindset while doing it but just the need to keep doing it.
- Can lead to “white knuckling” where pressure to perform overrides acting on the fear
- But fear conditioning remains and returns when pressure to perform is removed

See *Diagram 3D: Naive Behavioral Exposure*

**New:** The mindset while doing the exposure produces the effect
- Doing it mindfully will make it more effective.
- Focus on the desired goal: feeling the positive sense of confidence (safety, mastery, etc.)
- While expecting the fear to intrude, but respond by accepting and letting it pass through
- Constantly returning to the focus without becoming upset with the difficulty doing this

See *Diagram 3E: Mindful Emotional Exposure*

Change 3: Outcome Evaluation for Success

**Old:** Feel successful if less anxious
- It is an important secondary goal, but if make it primary then easier to get discouraged

**New:** Feel successful if more confident in sense of safety / mastery
- Judge progress by ability to do the self-talk and act on the sense of safety / mastery
- Some successes were tough and tenuous at times, but remember they were victories
- Also don’t give credit to luck or to the meds. It was own efforts not external forces.

Change 4: Expectations for Future Recurrence of the Fear

**Old:** Hope fear is gone and will never come back again
- Sets up to feel confused when it does which increases sense of uncertainty that increase fear
- Sets up to feel defeated which makes doubt that efforts worked

**New:** Know fear remains and its return means sense of safety / mastery needs bolstering
- Not surprised when it comes back because it was never gone, just put away in old circuit storage
- Stressed: reduces effectiveness of higher thinking circuits while increasing activation of lower emotional circuits
- Surprised: when caught off guard lower circuits are quick to act instinctively while slower and more cumbersome higher circuits take time to figure out what happened
- Strange: amygdala circuit responds to generalized gist which is similar between old and new situations while higher circuits respond to specific details which are likely to be different and new

Accept that you have hit “pot hole in the road of life” but remember that you know how to get out
- Focus on reactivating your coping skills and focus on them to get you through
- Take the time to reduce your stress level
- When have the time, think through what is different about this new situation
1. Overview of the Model

Hierarchical Levels of Neural Processing

<table>
<thead>
<tr>
<th>Brain Level</th>
<th>Main function</th>
</tr>
</thead>
<tbody>
<tr>
<td>Higher neocortical</td>
<td>Mindful examination of lower levels of experiencing</td>
</tr>
<tr>
<td>Higher human</td>
<td>Verbal thinking about how to respond to life situation</td>
</tr>
<tr>
<td>Neocortical</td>
<td>Emotional responding to life situations and others</td>
</tr>
<tr>
<td>Human</td>
<td>Instinctive adjustment of life processes for survival needs</td>
</tr>
<tr>
<td>Paleocortical</td>
<td>Automatic regulation of life processes to maintain homeostasis</td>
</tr>
<tr>
<td>Mammalian</td>
<td>Verbal thinking about how to respond to life situation</td>
</tr>
<tr>
<td>Brain nuclei</td>
<td>Mindful examination of lower levels of experiencing</td>
</tr>
<tr>
<td>Reptilian</td>
<td>Verbal thinking about how to respond to life situation</td>
</tr>
<tr>
<td>Brain stem nuclei</td>
<td>Emotional responding to life situations and others</td>
</tr>
<tr>
<td>Fish</td>
<td>Instinctive adjustment of life processes for survival needs</td>
</tr>
<tr>
<td>Spinal &amp; body nerves</td>
<td>Living existence</td>
</tr>
<tr>
<td>Body</td>
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Input of data | Decision making | Output actions |

Location of Nuclei within the Brain

Amygdala Regulation Problem

Amygdala is only danger detector

Turns "on" not "off"

Learns to fear sign of physiological arousal

Rapid heart rate

If no higher safety signal available

When detects arousal, it responds by

Positive feedback system

Sympathetic autonomic arousal

Increasing autonomic arousal

Intensity increases

Neocortical Anatomy

Neocortex is mainly two large multimodal association areas

PreFrontal Cortex Association Area

Parietal-Occipital-Temporal Association Area

Human neocortex is 3 times larger than chimpanzee

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2. Understanding Common Cognitive Errors

### Cognitive Distortion:

**All-or-none thinking**

You view a situation in only two categories instead of on a continuum.

**Catastrophizing**

You predict the future negatively without considering other, more likely outcomes.

**Emotional reasoning**

You think something must be true because you "feel" (actually believe) it so strongly, ignoring or discounting evidence to the contrary.

**Mental filter (selective abstraction)**

You pay undue attention to one negative detail instead of seeing the whole picture.

**Overgeneralization**

You make a sweeping negative conclusion that goes far beyond the current situation.

**Personalization**

You believe others are behaving negatively because of you, without considering more plausible explanations of their behavior.

**Imperatives like “should” or “must”**

You have a precise, fixed idea of how you or others should behave and you overestimate how bad it is that these expectations are not met.

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**Lower Level Explanation:**

Amygdala reactions are inherited and occur before higher level responses can take place. Amygdala responses are unmodulated shifts between on and off signals.

Amygdala's job is to alert if there are dangers so it will only be looking for dangers, so it will fire if there is any possibility of danger even if it is actually slight. It is the orbital's job to decide what the real probability of the danger is.

Paleocortical system is using emotional reasoning because that is the basis of its decision making and for it strong feelings are a major criterion for validation.

Norepinephrine concentrates attention on the "danger signal" to facilitate its processing by increasing the "signal-to-noise" ratio, so it will lock on and amplify the perceived danger and not attend to other inputs.

Implicit memory abstracts the essence of related experiences to make a general rule that it can habitually execute without thinking. It always uses the past to predict the future because it has no capacity to envision a different future.

Negative emotional thinking tends to be self-protective and sensitive to internal experiences so it will tend to use them as the basis for its interpretations.

Implicit automatic reactions are designed for executing and if they are blocked, they will amplify the urge to execute until they do execute.

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3. Exposure Diagrams

A. Amygdala Circuits for Fear

Adapted from Stahl, 3rd Ed, 2008

B. Extinction Study Diagrams


C. Goal of Exposure

Old View
To extinguish is to reduce this
Fear Conditioning
Goal = feel less anxious
Turn off the "on signal"

New View
To extinguish is to increase this
Fear Extinction
Goal = feel more calm
Turn on the "off signal"
Fear Conditioning
Not focus on this

D. Naive Behavioral Exposure

Naive Behavioral = "White knuckling"

Replace with Negative
Fear Override
Fear Conditioning
Reject and End

"White knuckling"
Can work if overriding emotion is intense enough to win
But not really extinguishing and fear conditioning remains activated and ready to reemerge

E. Mindful Emotional Exposure

Knowledgeable Emotion = Effective Exposure

Join with Positive
Fear Extinction
Fear Conditioning
Accept and Let Be

Add into the fear second soothing emotion which focus upon and judge progress by
Accept as inevitable but not focus on and just let pass through so not judge by presence