Neuroscience Advances for Improving Anxiety Therapies
Glenn Veenstra, Ph.D.

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Presenter Information:

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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) – superstitutious 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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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: Naïve 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 Reoccurrence 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

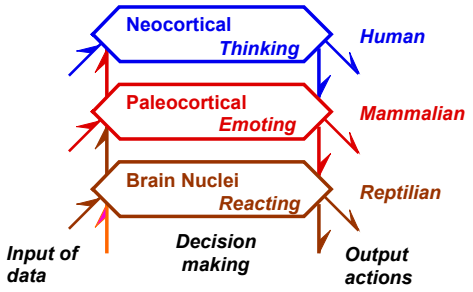
Accept that you have hit "pothole in the road of life" but remember that you know how to get out

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

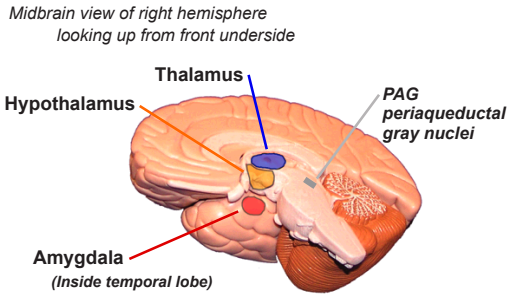
1. Overview of the Model

Hierarchical Levels of Neural Processing

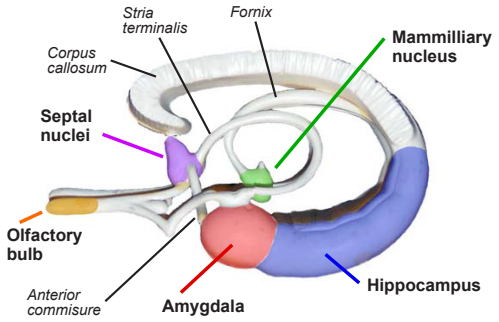
Brain Level	Main function
Higher neocortical *Higher human*	Mindful examination of lower levels of experiencing
Neocortical *Human*	Verbal thinking about how to respond to life situation
Paleocortical *Mammalian*	Emotional responding to life situations and others
Brain nuclei *Reptilian*	Instinctive adjustment of life processes for survival needs
Brain stem nuclei *Fish*	Automatic regulation of life processes to maintain homeostatis
Spinal & body nerves *Body*	Living existence



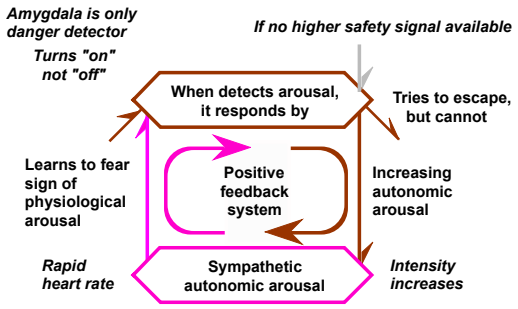
Location of Nuclei within the Brain



Limbic Nuclei

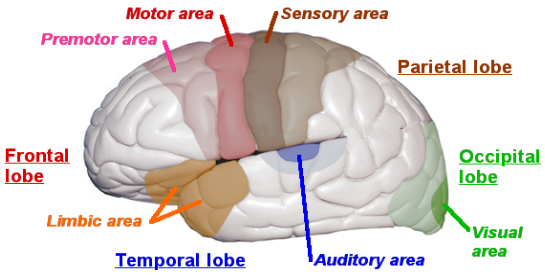


Amygdala Regulation Problem



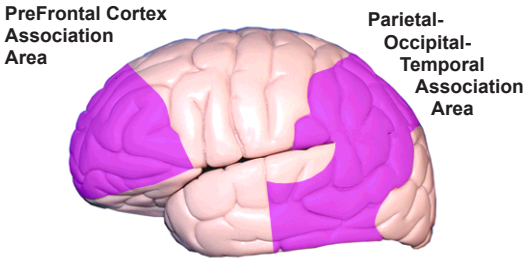
Paleocortical Anatomy

Sensory-motor areas are older parts of cortex



Neocortical Anatomy

Neocortex is mainly two large multimodal association areas



Human neocortex is 3 times larger than chimpanzee

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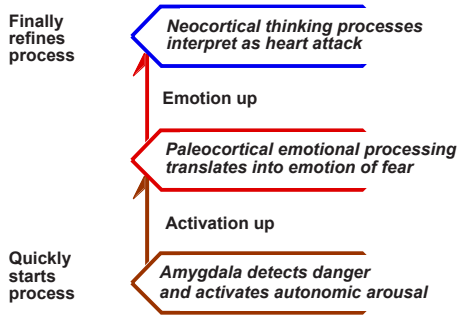
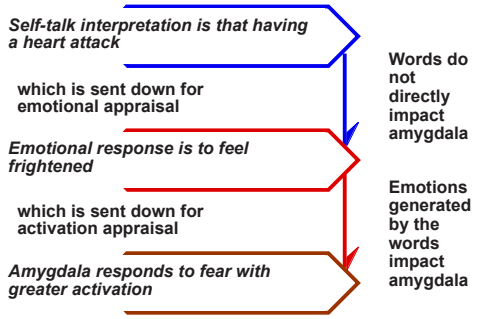
2. Understanding Common Cognitive Errors

Initial Reaction: Bottom-Up



Feedback Response: Top-Down



Cognitive Distortion:	*Lower Level Explanation:*
All-or-none thinking You view a situation in only two categories instead of on a continuum	*Amygdala reactions are inherited and occur before higher level responses can take plaace. Amygdala responses are unmodulated shifts between on and off signals.*
Catastrophizing You predict the future negatively without considering other, more likely outcomes	*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.*
Emotional reasoning You think something must be true because you "feel" (actually believe) it so strongly, ignoring or discounting evidence to the contrary.	*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*
Mental filter (selective abstraction) You pay undue attention to one negative detail instead of seeing the whole picture	*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.*
Overgeneralization You make a sweeping negative conclusion that goes far beyond the current situation	*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.*
Personalization You believe others are behaving negatively because of you, without considering more plausible explanations of their behavior	*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*
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	*Implicit automatic reactions are designed for executing and if they are blocked, they will amplify the urge to execute until they do execute*

Distortions from Judith Beck (1995) Cognitive Therapy: Basics and Beyond, p. 119

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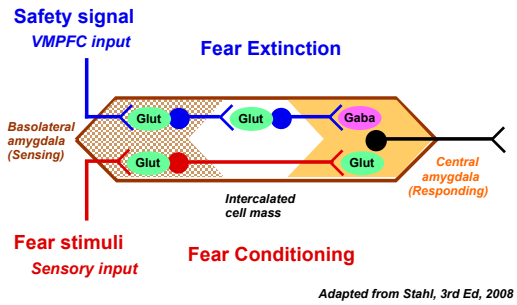
3. Exposure Diagrams

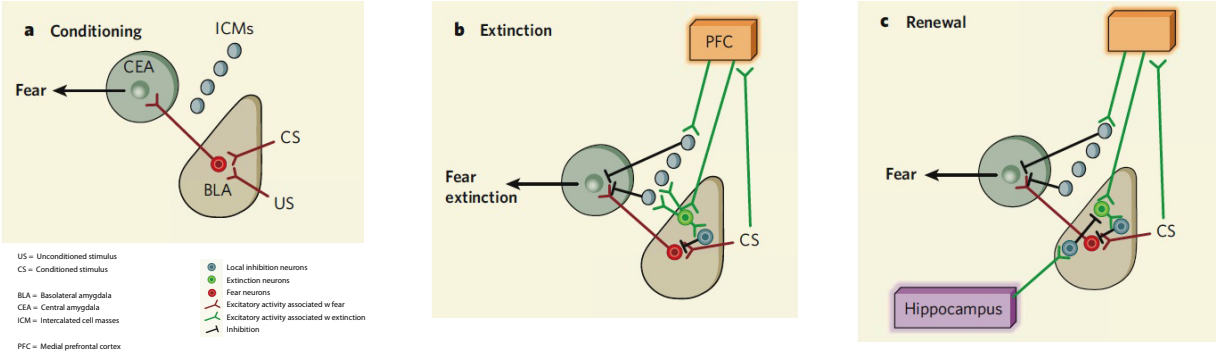
A. Amygdala Circuits for Fear



Adapted from Stahl, 3rd Ed, 2008

B. Extinction Study Diagrams

Sah, P. & Westbrook, R. (2008). The circuit of fear. ***Nature****, Vol 454, pp. 589-590*



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

Can work if overrriding emotion is intense enough to win

Fear Conditioning

But not really extinguishing and fear conditioning remains activated and ready to reemerge

Reject and End

E. Mindful Emotional Exposure

Knowledgeable Emotion = Effective Exposure

Join with Positive

Fear Extinction

Add into the fear second soothing emotion which focus upon and judge progress by

Fear Conditioning

Accept as inevitable but not focus on and just let pass through so not judge by presence

Accept and Let Be

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