The Cortex and Control of
Limbic ‘Tyranny’

- The Limbic System is our paleo-mammalian brain
- Limbic means border or edge i.e., brain structures between the cortex and brain stem
- Definition of included parts varies and includes:
  - Olfactory bulbs,
  - Hippocampus,
  - Amygdala:
    - Anterior thalamic nuclei & hypothalamus,
    - Fornix & columns of fornix,
    - Mammillary body,
    - Septum pellucidum,
    - Cingulate gyrus,
    - Parahippocampal gyrus,
    - Limbic cortex & midbrain areas

Limbic System Functions

- Contains neuronal “Hubs” for information processing and actions leading to homeostasis
- Include:
  - Hunger,
  - Thirst,
  - Response to pain,
  - Levels of pleasure,
  - Sexual satisfaction,
  - Anger and aggressive behavior,
- Regulates function of autonomic nervous system
Autonomic Nervous System

- **Sympathetic**: Fight or Flight
  - Increases metabolic demand (brain uses most blood in body, so therefore gets ‘recruited’ elsewhere = oops!)
  - Consumes cognitive resources
  - Impairs memory
  - Increases blood pressure
- **Para-sympathetic**: Counters sympathetic response and returns us to calm
Amygdala
[our own personal body guard]

- Not quite “Almond” shape structures in L&R temporal lobes
- Made up of over a dozen nuclei that are richly interconnected. Gets info from senses; sends response to body and brain; and integrates feedback from cortex
- We used to think amygdala served anger/fear function but it does more....
- Assesses what stimulus is and what’s to be done about it; aversive or pleasurable
- Forms associations between neutral and +/- stimuli across all 5 senses; lighting flash=thunder, “psst” sound=beer
The Prefrontal Cortex

Frontal Lobe Regions

Orbitofrontal cortex (OFC)*,
Dorsolateral prefrontal cortex (DLPFC),
Dorsal medial prefrontal cortex (DMPFC)*,
Ventrolateral prefrontal cortex (VLPFC)*,
Anterior cingulate cortex (ACC)*

*Strong reciprocal connections to amygdala
Antecedent-Based strategies for “Down Regulation” of emotions work better than Consequence-Based strategies

“Reappraisal” construing a potentially emotion-eliciting situation in non-emotional terms works better than
“Suppression” inhibiting ongoing emotion-expressive behavior

Sympathetic NS response measured by cardiovascular & electrodermal responses to arm amputation video
Antecedent-based strategies result in:
- ↓ Negative experience & expression
- ↑ Positive experience & expression
- No sympathetic activation

Consequence-based strategies result in:
- ↓ Negative & positive experience & expression
- Increased sympathetic response

Damage to the Ventromedial Prefrontal Cortex Impairs Learning from Observed Outcomes
Kumaran et al., Cortex 2015

“Our findings provide causal evidence that the vmPFC is necessary for normal learning of stimulus values from observed rewards, and point toward the conclusion that there are dissociable neural circuits for experiential and observational learning” p. 11

The role of the prefrontal cortex in dynamic filtering
Shimamura, et. al. Psychobiology 2000

Aspects of Executive Control and Dynamic Filtering Theory

<table>
<thead>
<tr>
<th>Executive Control</th>
<th>Related</th>
<th>Benchmark</th>
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<td>Process</td>
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<td>Activation</td>
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<td>Selecting</td>
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<td>Digit span Filter persistence</td>
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<td>Maintaining</td>
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When self-regulation is applied to cognition, it is called “metacognition” or thinking about your thinking which includes: “self-awareness or metacognitive beliefs, as well as self-monitoring and self-control of cognition while performing an activity”

1. Setting goals
2. Comparing performance with goals or outcomes (i.e., self-monitoring)
3. Making decisions to change one’s behavior in order to reach the desired outcome (i.e., self-control) (e.g., selecting an alternative solution)
4. Executing the change in behavior (e.g., implementing an alternative solution)

“Results provided sufficient evidence to make the clinical recommendation that metacognitive strategy instruction should be used with young to middle-aged adults with TBI, when improvement in everyday, functional problems is the goal”

Reappraising

• Be your own critical parent “I’m acting like a two-year-old and I need to grow up”
• Reframing – “He must be pretty insecure to have done this to me”, “She’s generally nice, she must be having a bad day”
• Ask what you might be doing to contribute to the problem
• Use humor and try to see the absurdity of the situation (w/caution)
• Work at accepting people while not liking their behavior
• Advocate a philosophy of tolerance “to err is human…”
• Cooperate rather than compete
• Advocate a philosophy of “S–t happens”

Antecedent Work

• Write these down! (even though it may feel trivial)
• What makes me tense?
• What situations trigger my anger?
• How do I typically react; especially early on?
• What are my beliefs/expectations about how others should/should not treat me?
• What did I do the last time I “lost it”?
• What’s your most severe response?
• What do I gain or lose from expressing my anger in this fashion?
• Keep a “Hassle Log” for self-monitoring
Applied Techniques

- Address possible underlying depression (e.g., in men). Change anti-depressant meds if dose is max. and still poor effect. Watch other meds (e.g., Beta-Blockers) rule out partial seizure, metabolic, endocrine, infection, pain etc.
- Ensure consistent environment, adjust antecedents
- Teach thought-stopping at first sign of identified personal triggers and teach:
  - Count to ten
  - Use deep muscle relaxation (taught in small group or 1-1, then applied)
  - Square breathing
  - iRelax
  - Guided Imagery
- Differentially reinforce use of techniques in applied settings

A Treatment Continuum
Ranchos Los Amigos Scale - Revised

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<td>Simple Strong Contingencies</td>
<td>Avoid (-) Reinforcement, CBT, Natural Contingencies</td>
<td>Teach Adaptive and Compensatory Skills</td>
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<td>High Environmental Consistency</td>
<td>Lower Environmental Consistency</td>
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<td>More medication</td>
<td>Taper medication</td>
<td>Discontinue Medication</td>
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<td>Ongoing Positive Support (don’t reinforce or imitate aggression)</td>
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**Metacognition (Mindfulness?)**

• Metacognition refers to a level of thinking that involves active control over the process of thinking that is used in learning situations and includes:
  – Planning the way to approach a learning task
  – Monitoring comprehension
  – Evaluating the progress towards the completion of a task
  – Maintaining motivation to see a task to completion
  – Being aware of distracting stimuli – both internal and external
  – Sustaining effort over time

• Specific metacognitive knowledge involves knowing:
  – What (factual or declarative knowledge)
  – When and why (conditional or contextual knowledge)
  – How (procedural or methodological knowledge).

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**So...How do get there?**

• The good news is that we can “rebuild” some frontal lobe control over limbic tyranny.

• The bad news is that it can be hard to get “buy in”-the very instruction to teach self-control (frontal control over limbic tyranny) often evokes emotional dysregulation. You can’t teach regulation while you are evoking dysregulation.

• First, a word about behavior function (or motivation)

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**Functional Assessment**

What are the possible functions of a behavior?
or......“What’s the payoff?”

The ABC form (run lots), Scatter Plots, Functional Analysis
Possible functions:
  a. Increase Attention
  b. Terminate Demands/Decrease Attention
  c. Seek Assistance/Help
  d. Access to Reinforcement (tangible or otherwise)
  e. Self-stimulation (automatic reinforcement)
These functions are the motivation-post injury, much of motivation is Escape
The Three Term Contingency

Antecedent (A) – Behavior (B) – Consequence (C)
– Basic unit of analysis for operant behavior
– All ABA procedures involve the manipulation of one or more components of the 3-term contingency

The Four-Term Contingency

• MO: Antecedent – Behavior – Consequence

• Now, all ABA procedures involve the manipulation of one or more components of the 4-term contingency.

Unfamiliar Terms

• This fourth-term Motivating Operation (MO) is a relatively recent addition. MO: Antecedent-Behavior-Consequence
• In sum, MOs have two defining effects. They alter (a) the effectiveness of consequences (the value-altering effect) and (b) the frequency of operant response classes related to those consequences (the behavior altering effect).

Let me give some examples, common and more specific to those with brain injury
Examples of Medical Setting Events or Motivating Operations

- Sleep Disturbance
- Poor Diet
- Metabolic Disorders
- Vestibular Disturbance
- Menses
- Otitis Media
- Medication effects
- Fatigue (prolonged physical exertion, sleep disturbance, temperature extremes, lack of sugar, salt, or water-or in brain injury extended periods of concentration)

Each of these can make other events aversive

What could make instructional demands aversive?

- Carbone, Morgenstern, Zecchin-Tirri, & Kolberg, (2010) suggested multiple sources for the aversive aspects of educational demands:
  - Removal of preferred activity (leaving something you like doing for instruction)
  - Instructional sessions which offer low rates of positive reinforcement
  - Situations that expose individuals to frequent social disapproval
  - High rates of demands
  - Frequent learner errors
  - And to this let me add the very real problems for individuals with brain injury of low processing speed and, thus feeling like a sudden failure compared to their previous learning performance. Thus, individuals act to escape demands.

Consequential Interventions for Escape Maintained Behaviors

- Consequential based procedures aimed at reducing escape-maintained behavior
  - Extinction alone (really not advisable)
  - Functional communication training (FCT) plus extinction (Hanley, Iwata & McCord, 2003)
  - Differential reinforcement of other behavior (DRO) (Vollmer et al., 1993)
Antecedent rather than Consequent-based Interventions

- Antecedent techniques aimed at reducing escape-maintained challenging behavior
  - Errorless Teaching (Ebanks & Fisher, 2003; Weeks & Gaylord, 1981)
  - Interspersal Training (Volkert et al, 2008)
  - Demand Fading (Pace, Ivanic, and Jefferson, 1994)
  - High-probability (high-p) Request Sequence (Mace & Belfiore, 1990)
  - Pre-session Pairing (Barbera, 2007; Sundberg & Partington, 1998)

Stimulus Fading as Treatment for Obscenity
Pace, Ivanic, and Jefferson (1994)

- Functional Analysis demonstrated that task demands evoked vocal obscenity for an adult man injured in an automobile 9 months prior.
- Obscenity decreased to near zero with reduction in demands (imbedded in non-contingent conversation) and remained under control as the frequency of task demands were increased gradually.
Effects of Pre-session Pairing on Challenging Behavior and Correct Responding of Children

- Procedure in which the therapist freely delivers preferred items or activities to the student, and engages in a “fun” way before presenting academic demands thus pairing themselves with the reinforcing activity/item and possibly altering pre-existing motivating operations.

Why does this work? For positively reinforced behavior and for negatively reinforced behavior?

- Well, for positively reinforced challenging behavior it may be that pre-session pairing temporarily reduces (abolishes) the motivation (attention) for the challenging behavior.
- For negatively reinforced challenging behavior it may be that pairing the instructor and educational setting with reinforcing activities may make those “stimuli” less important or reinforcing to escape from.
- Finally, pre-session pairing may increase the reinforcing value of instructor praise/attention that is typically contingent on correct academic responding. We’re not really sure, but there’s more research underway...
In baseline, most requests were met with noncompliance and challenging behavior. When a Functional Communication Response (“Break Please”) was taught, challenging behavior dropped to near-zero levels. When High Probability Requests (with reinforcement) immediately preceded Low Probability Requests, both challenging behaviors and FCR decreased substantially and compliance increased.
Behavior Analysis (and its cousin PBS) work well with the challenging behaviors of youngsters with brain injury or other neurological disorders (and everybody else for that matter).

When doing behavior analytic work one needs to use all the “tools in the box” to evoke positive change:

- Functional Behavior Assessment (FBA)
- Reinforcement of functionally equivalent, socially-acceptable behaviors
- Manipulation of 4th term variables (motivating operations) to decrease the probability of challenging behaviors, making reinforceable pro-social behaviors more likely.

Our take on what happens during the antecedent interventions discussed is that the limbic system is pre-emptively placated allow for cooperative behavior and learning to take place.

Some Takeaways

- Behavior Analysis (and its cousin PBS) work well with the challenging behaviors of youngsters with brain injury or other neurological disorders (and everybody else for that matter).
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Our take on what happens during the antecedent interventions discussed is that the limbic system is pre-emptively placated allowing for cooperative behavior and learning to take place.