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Memory Reconsolidation, Emotional Arousal and the Neuroscience of Enduring Change: Implications for Psychoanalysis

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Berggasse 19, 1090 Wien

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12-Session Course At The Medical University of Vienna

- Session 1 (3/7/23): Memory reconsolidation, emotional arousal and the process of enduring change
- Session 2 (3/14/23): Recurrent maladaptive patterns
- Session 3 (3/21/23): Memory-emotion interactions
- Session 4 (3/28/23): Sleep, napping, dreaming and memory reconsolidation
- Session 5 (4/18/23): Unconscious (embodied) emotion and the neural basis of emotional experience
- Session 6 (4/25/23): Emotional awareness: evolution, development and the consequences of trauma

12-Session Course At The Medical University of Vienna

- Session 7 (5/2/23): Dynamic unconscious revisited
- Session 8 (5/16/23): Clinical expression of impaired emotional awareness
- Session 9 (5/23/23): Treatment implications: corrective emotional experiences and the corrective emotional relationship
- Session 10 (6/6/23): Research implications: basic science and clinical research agenda for the memory reconsolidation model
- Session 11 (6/13/23): Research findings during this fellowship
- Session 12 (6/20/23): The place of psychoanalysis in relation to other psychotherapy modalities

Administration of the Course/ Housekeeping Details

- Start on Time: Tuesdays at 4:30 pm CET (90 minutes)*
- Plan 60 minutes of lecture and 30 minutes of discussion
  - please interrupt lectures for clarification only
  - write down questions for Q&A and discussion
- Optional: Discussion session Wednesday 4:30 pm CET (90 min)
- Please do the readings in advance (available by link via email)
- Attendance encouraged; no formal evaluation
- Laptops and phones – for note-taking only; step out if needed
- Fulbright: academic ambassador; dialogue and open exchange
- Psychoanalysis: traditional theory vs. neural systems perspective

Adminstration of the Course / Housekeeping Details

- Zoom recordings: 4:15-6:15 pm CET
- Discussion sessions on Wednesday will be recorded also
- Live attendees by zoom in USA, EU and elsewhere
- Please be patient with technical challenges (zoom, local AV)
- Zoom links to recordings posted on NPSA and UArizona websites
  - available by pre-registration via email
  - MUV students registered for course: please attend in person
- My speaking speed and clarity: please give me feedback
- Please speak up: grammatical mistakes in English are OK
- Definition of terms and concepts – is a glossary needed?
- If you wish to contact me: lane@arizona.edu

Memory Reconsolidation, Emotional Arousal and the Neuroscience of Enduring Change: Implications for Psychoanalysis

- A neural systems approach to enduring change in psychotherapy and psychoanalysis
- Memory reconsolidation (MR)
- Core MR theory: BBS paper in 2015
- Other memory-emotion interactions in psychotherapy
- Implications for clinical practice
- Implications for clinical research

Why Do We Need A Theory of How Psychotherapy Works?

- What are the essential ingredients of any given modality? (Can it be improved or be made more efficient?)
- What should be taught to trainees learning psychotherapy? (Is an integrative framework possible?)
- How do we select which therapy to provide for a given patient? (If we understand how therapies work and how they differ this should be possible.)
- Can we understand the neurobiology of change?
- Can we eventually predict using objective measures who will respond to which therapy?

Mechanisms of Change in Psychotherapy Are Poorly Understood

"After decades of psychotherapy research, we cannot provide an evidence-based explanation for how or why even our most well studied interventions produce change, that is, the mechanism(s) through which treatments operate."

Kazdin A. Mediators and mechanisms of change in psychotherapy research. Annual Rev Clin Psychol 2007; 3:1–27.

Freud's Dream: A Brain-Based Understanding of Mind

"We must recollect that our provisional ideas in psychology will presumably some day be based on an organic substructure. . . . We are taking this probability into account in replacing the special chemical substances by special psychical forces." [Freud, 1914, pp. 78–79]

"The deficiencies in our description would probably vanish if we were already in a position to replace the psychological terms by physiological or chemical ones." [Freud, 1920, p. 60]

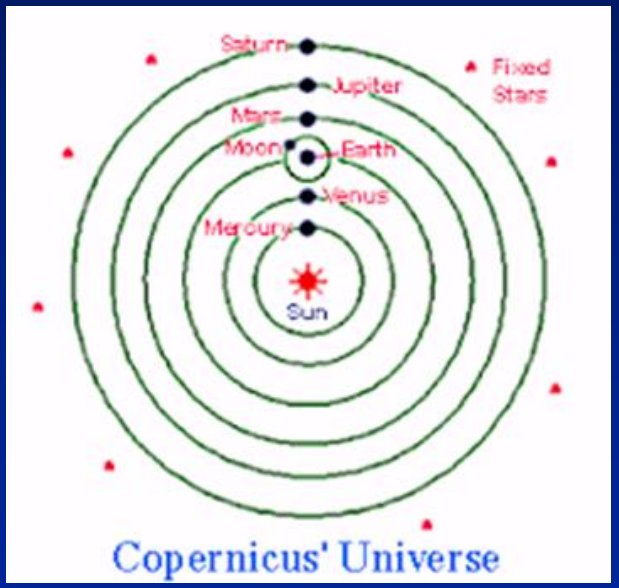
"Biology is truly a land of unlimited possibilities. We may expect it to give us the most surprising information and we cannot guess what answers it will return in a few dozen years to the questions we have put to it." [Freud, 1920, p. 60]

Sunset in Tucson, Arizona – the Sonoran Desert

Why Does the Sun Disappear Over the Horizon in the Evening?

Sun actually sets in the west

Earth rotates on its axis



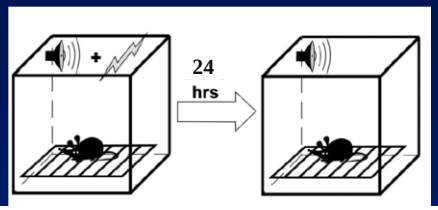
- To the human eye, these two mechanisms look identical
- The mechanism underlying phenomenology matters a lot !!

Whole New Worlds Open Up When Mechanisms Are Understood

Galileo Galilei (1564 – 1642)
Pioneered use of the telescope

Fear memories require protein synthesis in the amygdala for reconsolidation after retrieval

Karim Nader, Glenn E. Schafe & Joseph E. Le Doux



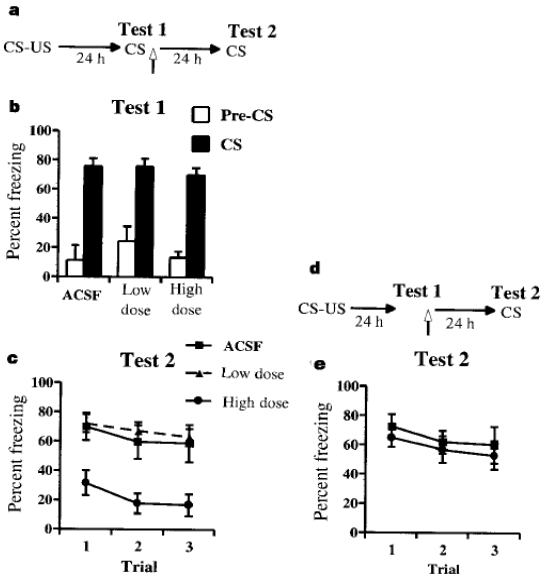


Figure 2 A test of whether consolidated fear memories can become labile when reactivated. **a**, The behavioural procedure used for experiment 1A. **b**, Freezing to the CS on test 1 was comparable across groups and was specific to the CS. **c**, Intra-LBA anisomycin infusions after reactivation of a consolidated fear memory produce amnesia for the original learning, as measured on test 2. **d**, **e**, Rats demonstrated normal memory if the CS was omitted before anisomycin. **d**, The behavioural procedure used for experiment 1B. Rats were placed in the test chamber and received infusions of anisomycin. **e**, Percent freezing on test 2. Figure legend is applicable to both **c** and **e**. Vertical open-headed arrows represent infusions. All data points represent group means ± s.e.m.

Nature 2000; 406: 722-726

Known: protein synthesis is necessary for memory consolidation

Rats were conditioned by pairing a tone (CS) with a foot-shock (US)

Wait 24 hours (sleep; protein synthesis)

Exposure to the CS → freezing

Untrained tone → no freezing

Anisomysin only → freezing

CS + anisomysin → no freezing

Reactivation of the memory (CS only) puts the memory in a labile state

Injection of a protein synthesis inhibitor into the amygdala erased the memory

We now think that whenever memories are retrieved they are available for updating and then *re*consolidated with new information presented in the labile state.

Memory: It's Not Just for Recalling the Past; It's a Guide to the Future

- Memory is adaptive because it keeps a record of what did and didn't work in the past
- The key benefit is that it serves as a guide to similar situations in the future
- In fact, the brain is constantly making predictions about what is happening now and likely to happen in the near future based on these memories
- Having some capacity to update memories in light of changing circumstances can optimize adaptive flexibility -- but changes must be made prudently.

What is this?

The Power of Predictive Processing: The Role of Expectations in Perception

Anil Seth. Being You: A New Science of Consciousness. 2021

BEHAVIORAL AND BRAIN SCIENCES (2015), Page 1 of 64
doi:10.1017/S0140525X14000041

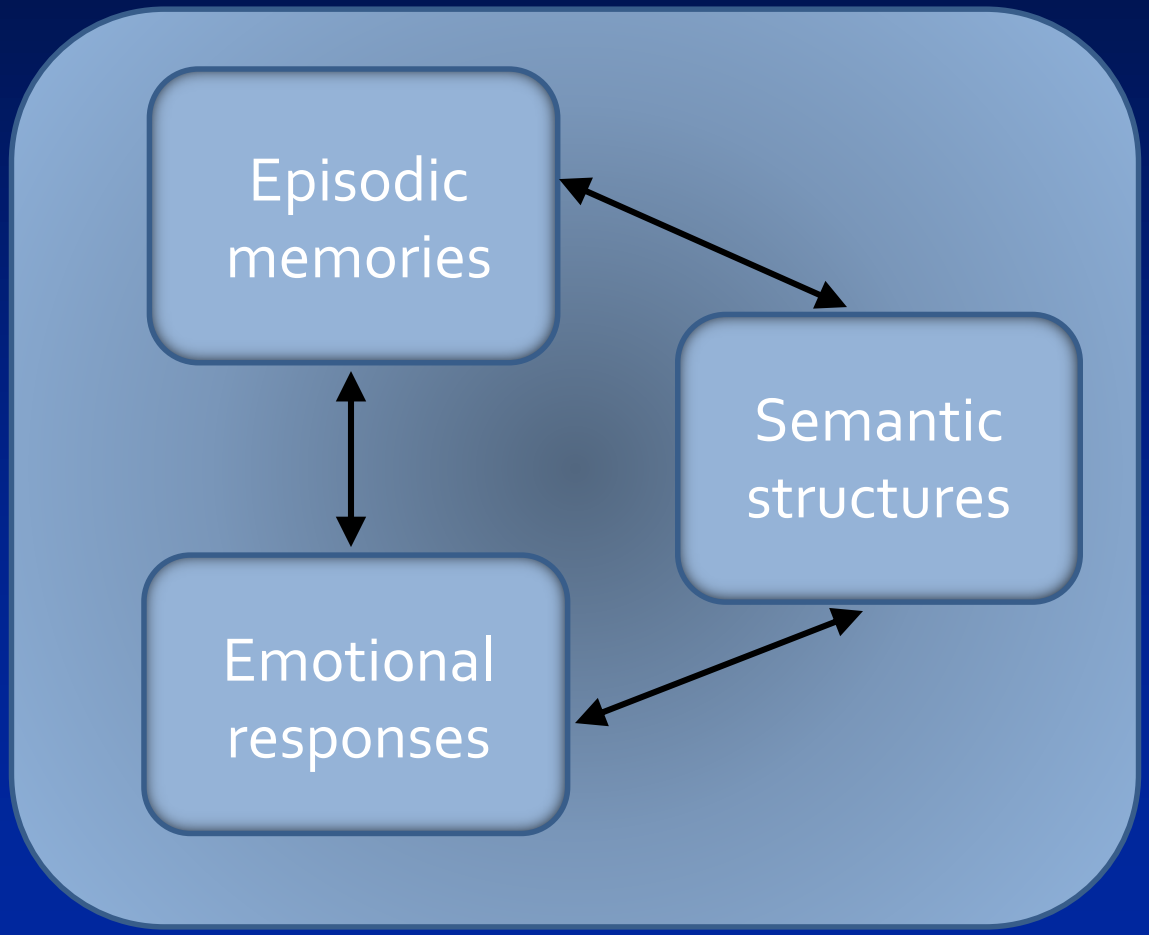
Memory reconsolidation, emotional arousal, and the process of change in psychotherapy: New insights from brain science

Richard Lane, M.D., Ph.D., Prof of Psychiatry, U of Arizona
Lee Ryan, Ph.D. Professor of Psychology, U of Arizona
Lynn Nadel, Ph.D. Professor of Psychology, U of Arizona
Les Greenberg, Ph.D. Professor of Psychology, York U

BBS Editor (Barbara Finlay), 6 anonymous reviewers and and 28 commentators

Lane, R. D., Ryan, L., Nadel, L., & Greenberg, L. (2015). Memory reconsolidation, emotional arousal, and the process of change in psychotherapy: New insights from brain science. *Behavioral and Brain Sciences*, *38*, 1-19.

Integrated Memory Model



It is impossible to activate one without the others.

- Personal experiences
- Generalized knowledge
- Arousal, action, feeling

Emotional Arousal Is Necessary for Therapeutic Change

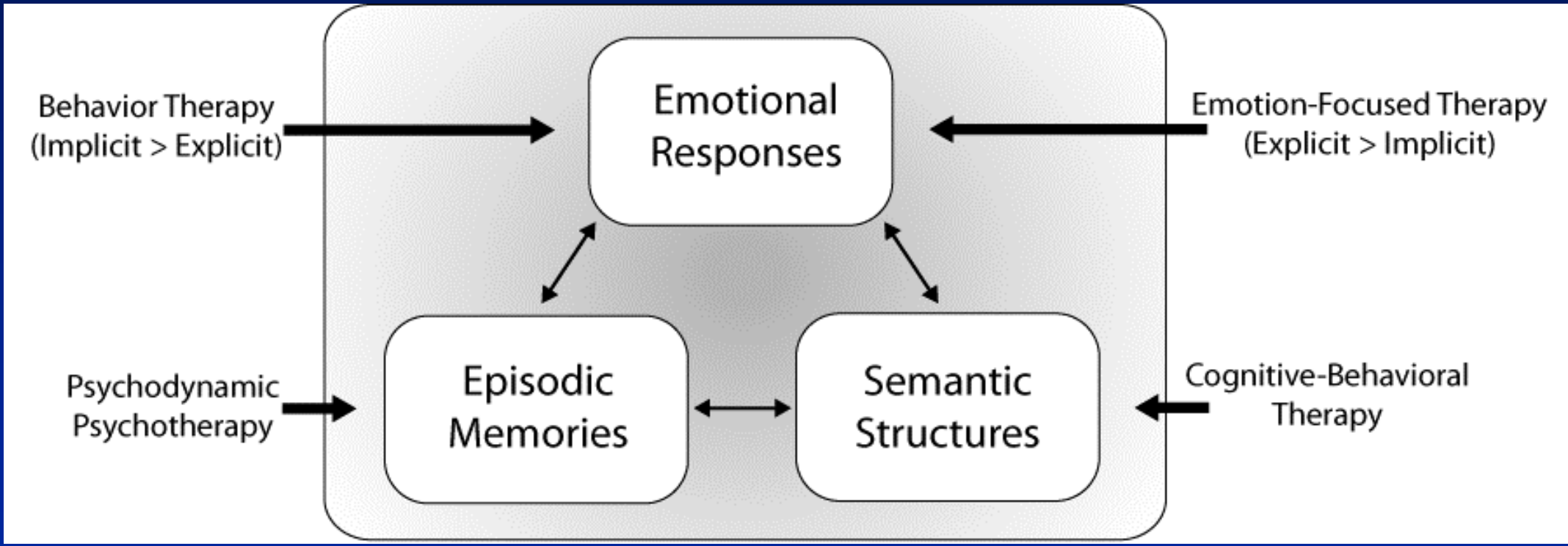
- High physiological arousal during exposure therapy is a predictor of its effectiveness
- Multiple studies of Emotion-Focused Psychotherapy show that in-session arousal is associated with better therapy outcome
- Psychodynamic therapy: insight without adequate affective engagement unlikely to produce lasting results

Emotional Arousal Enhances Memory Encoding

Synaptic plasticity, which is the molecular basis for encoding memories, is enhanced by the neurotransmitters and hormones (e.g. norepinephrine, cortisol) that are activated by emotional arousal.

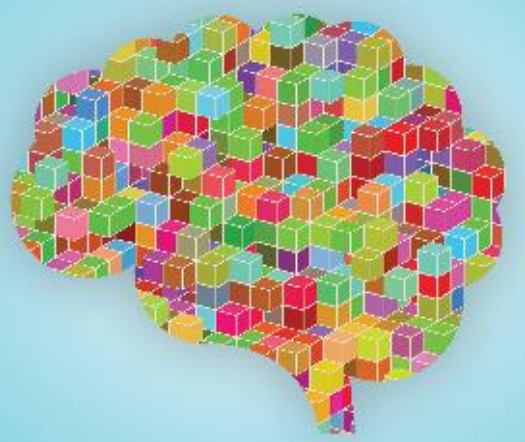
Schwabe L, Joëls M, Roozendaal B, Wolf OT, & Oitzl MS. Stress effects on memory: An update and integration. *Neuroscience & Biobehavioral Reviews*. 2012; 36:1740-1749

Major Psychotherapy Modalities Differ in Their Points of Entry



NEUROSCIENCE OF ENDURING CHANGE

Implications for Psychotherapy



EDITED BY

RICHARD D. LANE
& LYNN NADEL

OXFORD

Overview

1. Lynn Nadel and Richard D. Lane. Neuroscience of Enduring Change and Psychotherapy: **An Introduction**.

Basic Science Perspectives

2. Lynn Nadel. **What is a Memory That It Can Be Changed?**

3. Ryan Smith. **The Three-Process Model of Implicit and Explicit Emotion**.

4. Ajay B. Satpute, Erik C. Nook and Melis E. Cakar. **The Role of Language in the Construction of Emotion and Memory: A Predictive Coding View**

5. Jessica R. Andrews-Hanna, Kalina Christoff and Mary-Frances O'Connor. **Dynamic Regulation of Internal Experience: Mechanisms of Therapeutic Change.**

6. Joseph E. Dunsmoor and Marijn C.W. Kroes. **Emotion-memory interactions: implications for the reconsolidation of negative memories.**

7. Jessica D. Payne. **Stress and sleep interact to selectively consolidate and transform negative emotional memories: Implications for Clinical Treatment**

8. Matthew D. Grilli and Lee Ryan. **Autobiographical Memory and the Self-Concept**.

Clinical Psychotherapy Perspectives

9. Antonio Pascual-Leone and Leslie S. Greenberg. **Emotion Focused Therapy: Integrating Neuroscience and Practice.**

10. Jonathan D. Huppert, Isaac Fradkin and Shawn P. Cahill. **CBT for anxiety disorders: Memory reconsolidation theory and its relationship to cognitive, emotional processing, and inhibitory models.**

11. Bruce Ecker. **Erasing Problematic Emotional Learnings: Psychotherapeutic Use of Memory Reconsolidation Research**

12. Hanna Levenson, Lynne Angus and Erica Pool. **Viewing Psychodynamic/Interpersonal Theory and Practice through the Lens of Memory Reconsolidation**.

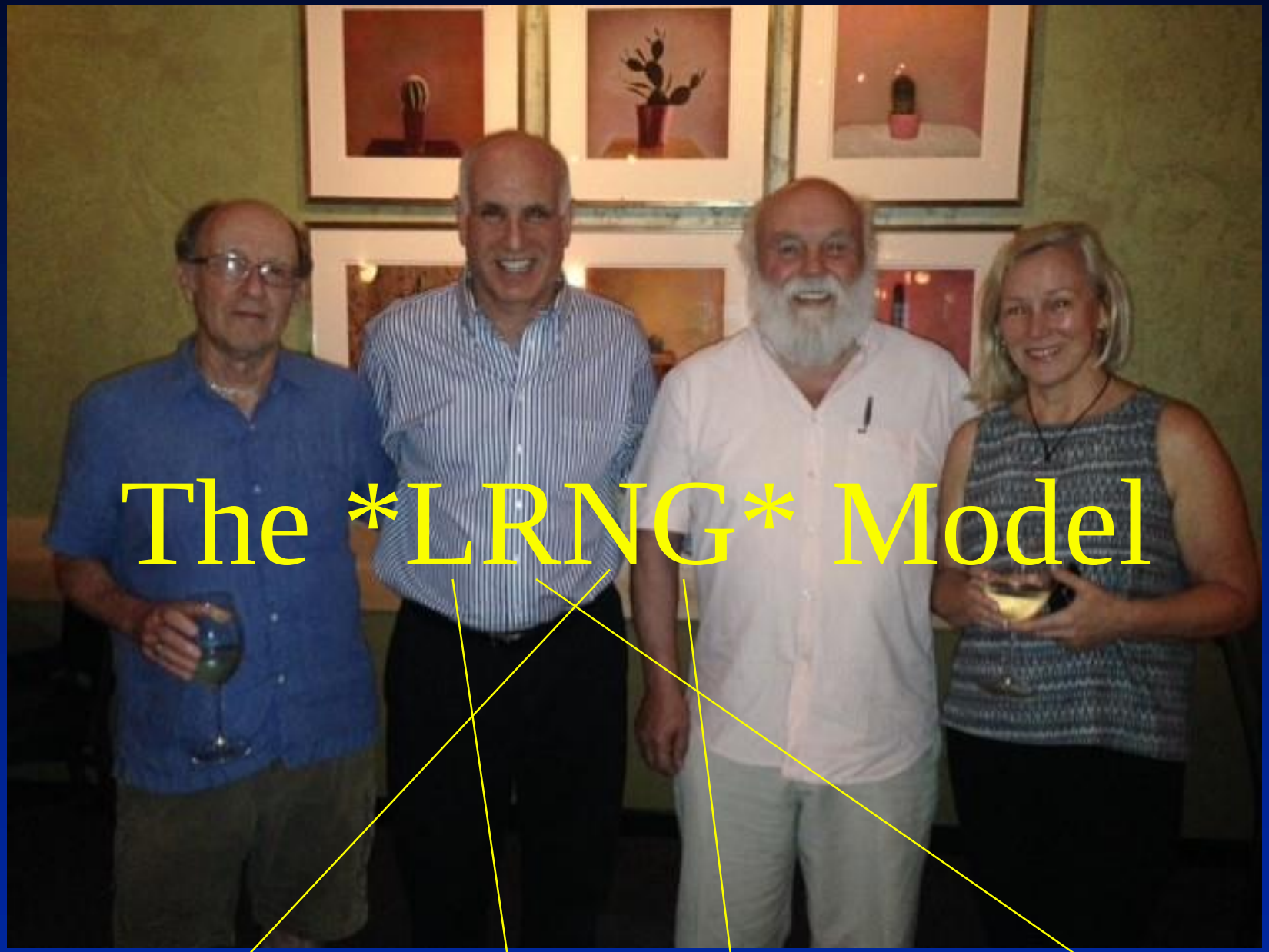
13. Rhonda Goldman and Alyssa Fredrick-Keniston. **Memory Reconsolidation as a Common Change Process: Moving Toward an Integrative Model of Psychotherapy**

Integrative Perspectives

14. Richard D. Lane. **The Affective Origin and Treatment of Recurrent Maladaptive Patterns**.

15. Ryan Smith, Richard D. Lane, Lynn Nadel, and Michael Moutoussis. **A computational neuroscience perspective on the change process in psychotherapy.**

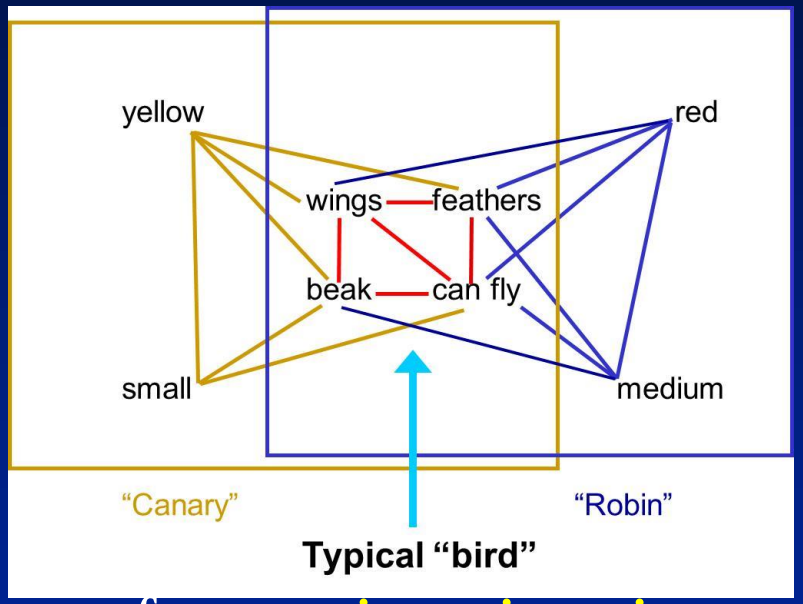
16. Richard D. Lane, Ryan Smith and Lynn Nadel. Neuroscience of Enduring Change and Psychotherapy: **Summary, Conclusions and Future Directions**.


The *LRNG* Model
Lynn Nadel
RDL
Les Greenberg
Lee Ryan

Core Theory: The LRNG Model Proposed Essential Ingredients For Enduring Change in Psychotherapy

- Activate old memories and old feelings (with or without awareness of their connection to the past)
- Concurrently engage new emotional experiences that change old memories through reconsolidation
- Reinforce the strength of new memories and their semantic structures by practicing new ways of behaving and experiencing the world in a variety of contexts

Working Through: Making the Transition from Episodic Memories to Semantic Structures



Relevant features of recurring situations are extracted including who is involved, what transpires, how it feels, how to respond and how others respond to you. These memories are the elements of the internal working model of how the world of social relationships operates.

Recurrent Maladaptive Patterns: A Type of Schema

- Clients often come to psychotherapy because they are unhappy with aspects of their social or occupational lives.
- They are typically unaware that this is part of a behavioral pattern triggered by interpersonal situations that are "reminders" of problematic situations from the past.
- Examples
  - Stern: Representations of Interactions Generalized (RIGs)
  - Luborsky: Core Conflictual Relational Theme (CCRT)
  - Strupp and Binder: Cyclical Maladaptive Pattern (CMP)
  - Horowitz: Recurrent Maladaptive Interpersonal Pattern (RMIP)

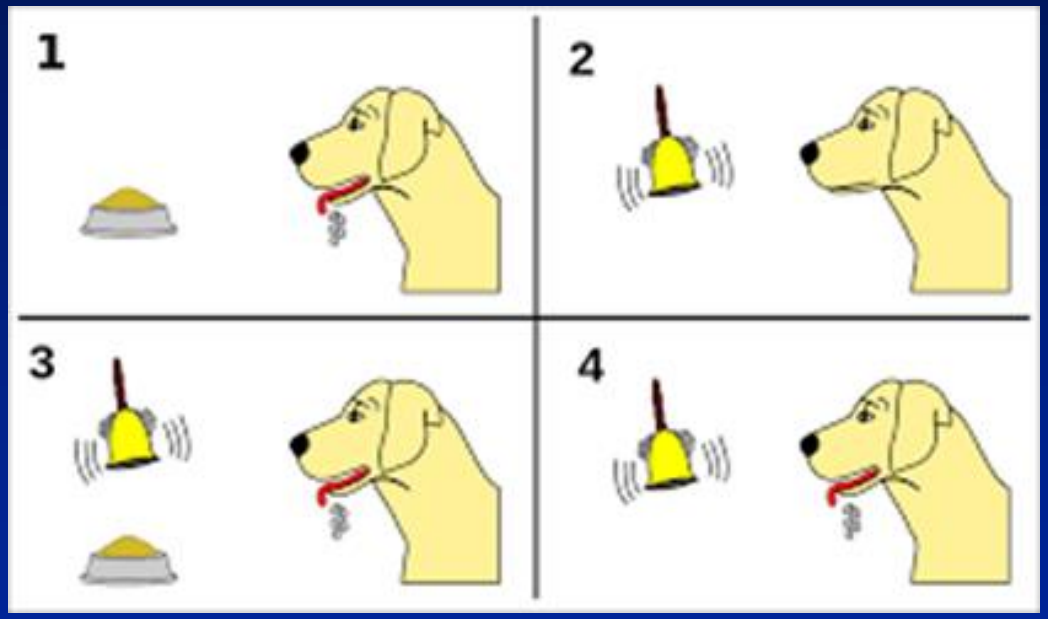
The Importance of Schemas

A major conclusion from our book is that the focus of change in psychotherapy is schemas.

- Schemas
- Semantic memories
- Internal Working Model (Bowlby)
- Recurrent maladaptive patterns

Neuroscientific knowledge about how schemas develop and change is quite limited but is a very ripe area for new research.

Memory Reconsolidation vs. Extinction



Classical (Pavlovian) Conditioning

Repeated presentation of the bell (4) (CS) without the food (US) leads to extinction of the salivary response

The original memory (CS-UCS) (3) is suppressed (extinction) by creation of a new memory

The original memory is retained and can be reactivated under appropriate circumstances

Elements of Psychotherapy That May Favor Memory Reconsolidation Over Extinction

- The *latent causal structure* of a situation determines whether a *new* memory is formed or an *old* one is modified
- Memory reconsolidation (changing the old memory) is favored when:
  - the new situation resembles the old in many ways
  - changes are slow and gradual, as opposed to abrupt
- Memories that are hardest to change or update are older, stronger, and more differentiated

Gershman SJ, Monfils MH, Norman KA, Niv Y. The computational nature of memory modification. Elife 2017; 6:e23763.

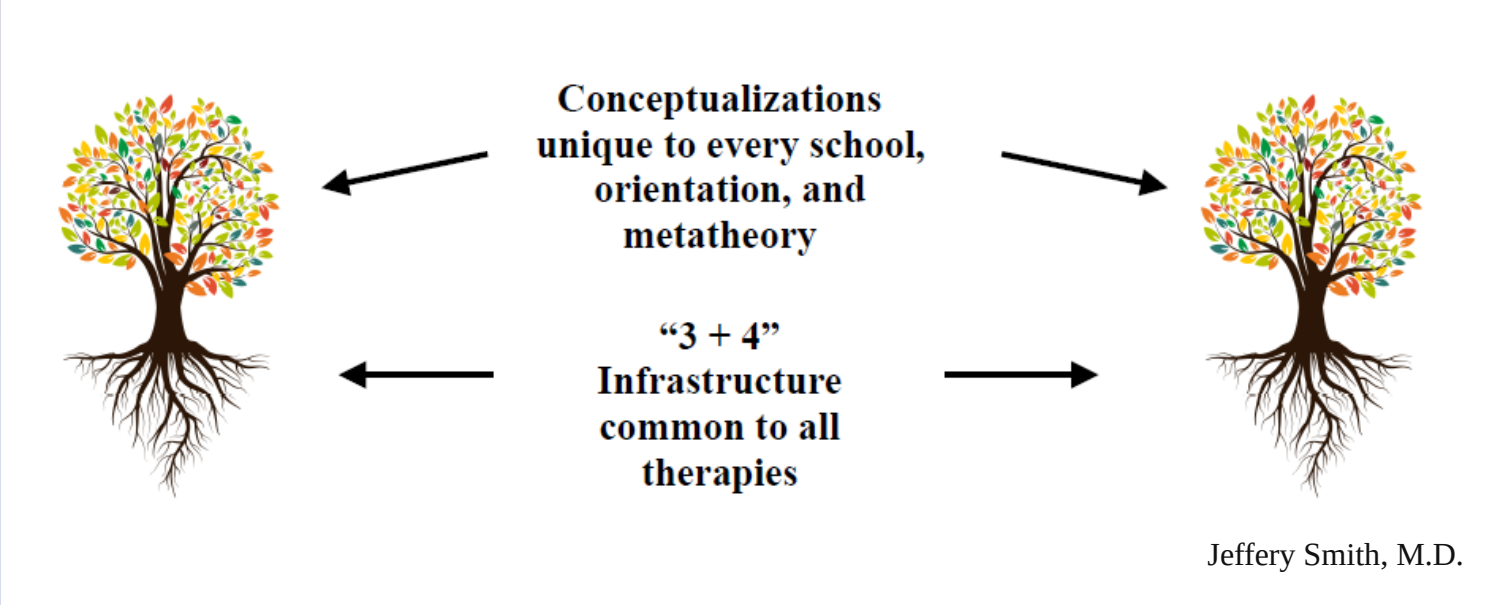
Different Types of Memories with Emotional Content

1) Classical conditioning
   associative learning that involves pairing a CS and US
2) Associative learning
   emotionally neutral content + unrelated emotional arousal
3) Reinforcement learning
   affective consequences of an action change its value
4) Episodic memories with strong emotional content vs. those without
   e.g. trauma memories
5) Schemas with inherent emotional content such as implicit affective learning, e.g. see Ecker
6) A combination of schemata
   internal working model of social world expectancies

Updating Memories: Time Course of Change

- Episodic -- easiest to update
- Semantic – harder to update
- Procedural / Habit – hardest to update

SEPI's Mission: Convergence and Integration



3 Final Pathways

New Learning (outcompetes)
Extinction (suppresses)
Memory Reconsolidation (updates)

3 Key Steps

Reactivate
Revise
Reinforce

4 Facilitating Factors

Arousal regulation
Motivation
Safety
Relationship

Implications for Psychodynamic Psychotherapy

- Active recall of past experiences (1), promotion of intense emotional experiences including new experiences in the transference (2), and the emphasis on working through in a variety of contexts (3) is highly consistent with MR theory

- Perhaps the process of creating trust, establishing the working alliance, and enabling and working within the transference constitutes critical implicit emotional learning that paves the way for new explicit corrective experiences

Implications for Psychodynamic Psychotherapy (PDT) and Psychoanalysis

- Is working on the recurrent maladaptive pattern *within* the transference relationship with the therapist always necessary?
  - Perhaps activating old memories and having new experiences is sufficient in PDT.
  - Perhaps high frequency psychoanalysis (4-5x/week) is indicated when working within the transference relationship is necessary to promote epistemic trust
- Unsuccessful analyses – may be due to reliving the old experiences without having enough new experiences to alter the old memories

Implications for Emotion-Focused Psychotherapy

- Activation of old memories through reminders in the present *is* important even though explicit efforts to recall the past are not emphasized
- Semantic structures, not just emotions, are being updated when clients are asked to adopt different perspectives in 2-chair work
- Effectiveness of EFT may be related to the potent effect that emotional arousal has on memory
- Activation of negative emotion may facilitate learning

Learning Rate May Be Faster In the Context of Negative Affect

- Unpleasant arousal may amplify the degree to which prediction error updates memories/expectations
- In computational terms, this occurs via altering precision-based modulation of prediction error

Joffily & Coricelli, 2013
Clark, Watson, & Friston, 2018

Implications for Cognitive-Behavioral Therapy (CBT)

- Classic theory: △ thoughts ⟶ △ emotions
- Possible shift in emphasis: it may not be the change in thoughts that matters as much as the resulting change in emotional experience in a variety of contexts that enables reconsolidation of memories
- Emotion is a mechanism of change in CBT, not just an outcome

  △ emotions ⟶ △ thoughts

Implications for Cognitive-Behavioral Therapy (CBT)

- Highlights the importance of *successful* homework
- Helps to explain why rumination, or unsuccessful homework, is problematic – it further ingrains the old memories
- Highlights that enduring change requires *changing* the semantic structures (the internal working model), not just reducing emotional distress by temporarily altering thoughts

Memory Reconsolidation Clinical Research Agenda

- Defining enduring change
- Selecting appropriate outcome variables
- Number and type of corrective emotional experiences
- Napping and sleeping
- Number, duration and spacing of sessions
- Demonstrating that change is due to MR
- Capturing the change process in fMRI

Napping and Sleeping

- Consolidation and reconsolidation happen during sleep
- REM sleep preferentially consolidates emotional aspects of memory
- Is the same true for emotional memory reconsolidation?
- Might dreams be a real time readout of MR as it occurs?
- Highlights importance of sleep quality and duration
- Napping has been shown to enhance explicit recall of verbal material
- Power nap after a session? (timing? duration? REM/NREM?)
- Rehearsal or review of corrective emotional experience at bedtime?

What If Psychotherapy Practice Were Based on MR Principles?

- The reconsolidation window stays open after the session; arousal (e.g. exercise) after a session can tag what came before; nap/sleep can "lock in" change
- Issues to consider
  - Retreat-style intervention
  - Duration of sessions
  - Frequency of sessions
  - Post session activities
  - Napping
  - No meds that alter REM (SSRI, SNRI, TCA, BZ)

Requirements for Demonstrating Memory Reconsolidation (Elsey, Van Ast and Kindt, 2018)

- Reactivation x Manipulation interaction
- Time dependency
  - intervene within time window of 4-6 hours
- Memory specificity
- Dissociation of immediate and delayed effects
  - sleep is necessary for reconsolidation
  - demonstrate altered memory the next day and in long-term follow-up (e.g. 1 year)

Benefits of Grounding Theory and Practice of Psychotherapy in MR Neurobiology

- Practice
  - Provides general guidance in executing therapy
  - Provides specific guidance in face of uncertainty
  - Provides guidance when therapy stalls or fails
- Research
  - Provides empirical grounding of concepts and processes
  - Provides methods for measuring change based on MR
  - A source of new predictions and hypotheses
    - e.g., sleeping, napping, dreaming

General Conclusions

- Therapeutic change in a variety of modalities may result from the reconsolidation of emotional memories by incorporating new emotional experiences in contexts reminiscent of the original problematic situations.
- Change in psychotherapy has 3 necessary ingredients:
  1) Activate old memories including the old feelings
  2) Activate new emotional experiences
  3) Practicing new ways of experiencing the world in a variety of contexts
- This model may apply to all psychotherapy modalities that aspire to achieve enduring change

Conclusions – Caveats and Cautions

- MR has not yet been unequivocally demonstrated in in humans, although much evidence exists
- Alternative explanations still cannot be excluded
- Case examples lack experimental controls needed to meet the most rigorous standards of proof
- Lack of definitive proof doesn't mean it's not occurring
- Little is known about reconsolidation of semantic or schematic memories – important growth area
- Viable option: make predictions, get results, consider and rule out alternative explanations when possible

Acknowledgement

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