Love, Lies & Limbic Systems

What neuroscience actually says about our relationships

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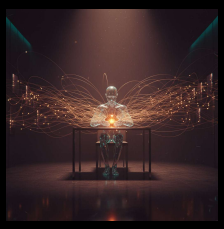
First, a lesson in Variables

- Brain structures
- Neurochemicals
- Encoding
- Genetics
- Development
- Experiences
- Relationships
- Culture
- Trauma
- Healing
- Learning
- Time
- Presence (Consciousness)
- Sensitivity



Overview section. Core sources: Berridge & Robinson (2016); Feldman (2017); Young & Wang (2004); Gunnar & Quevedo (2007).

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Brain structures/regions

- **Amygdala**
  - notification center for survival needs (FFFFF), not fear center
- **Prefrontal Cortex (PFC)**
  - Executive function – decision making, planning, working memory, attention
  - Behavior & Emotion – self-control, emotional regulation, social behavior, personality expression
- **Hippocampus**
  - Memory formation, memory recall, contextual memory, spatial awareness/navigation, emotional linking (amygdala/PFC)

Azevedo et al. (2009); Finn et al. (2015); Berridge & Robinson (2016); Shamay-Tsoory & Abu-Akel (2016); Young & Wang (2004); Kross et al. (2011).

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Neurochemicals to carry into each myth that follows…

1. **Dopamine is a predictor for wanting/learning survival/thriving (not** pleasure/reward chemical). Fires hardest w/uncertainty, novelty, curiosity, prediction error.
2. **Oxytocin is an amplifier of risk & reward.** It turns up whatever is already there. In a frightened brain, that includes the fear. (Social amplifier)
3-4. **Vasopressin is a partner guard** (oxytocin's cousin)
Serotonin is a mood stabilizer. Receptor distribution, not chemical quantity, is what differs individually
5-6. **Norepinepherine & Cortisol are alarm systems (two speeds).** immediate/seconds vs minutes/hours. Chronic activation degrades system, decreasing sense of safety & processing ability
+ **Endogenous Opioids:** Relationship attachment neurochemicals
- **Beta-endorphins** – reduces pain
- **Enhaphalins** – small peptides found in brain & gut, handle early pain signals
- **Dynorphins** - A group of strong pain-control peptides; control mood, stress responses, and pain.
- **Nociception/Orphanin FQ** - Helps manage how the body senses pain, anxiety, and learning

Azevedo et al. (2009); Finn et al. (2015); Berridge & Robinson (2016); Shamay-Tsoory & Abu-Akel (2016); Young & Wang (2004); Kross et al. (2011).

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More neurochemicals: Common Hormones

Hormone	Males	Females
Testosterone (drive & activation)	Strength • Muscle • Endurance • Libido • Arousal • Motivation • Mood • Emotional regulation • Confidence • Energy • Bone health • Sperm production	Strength • Muscle • Endurance • Libido • Arousal • Motivation • Mood • Emotional regulation • Energy • Bone health • Ovulation
Estrogen/Estradiol (plasticity & connection)	Libido • Arousal • Mood • Emotional regulation • Cognition • Bone health • Cardiovascular health • Sexual function	Libido • Arousal • Mood • Emotional regulation • Cognition • Bone health • Cardiovascular health • Sexual function • Ovulation • Menstrual regulation
Progesterone (regulation & stability)	Mood • Emotional regulation • Brain function • Neuroprotection • Sleep • Sexual function	Mood • Emotional regulation • Brain function • Neuroprotection • Sleep • Sexual function • Ovulation • Menstrual regulation • Pregnancy support

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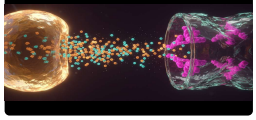
WHY "NORMAL" IS NOT A THING

The math that makes a "normal" human impossible!

~100 trillion

Estimated synaptic connections in one adult human brain — built from roughly 86 billion neurons, each forming thousands of contacts.



- **The arithmetic.** Neuron count is now well established at about 86 billion, not the 100 billion that circulated for decades (Azevedo et al., 2009) — and each of those neurons forms some 1,000–10,000 synapses.
- **Synaptic Space.** Memory is stored as changes in synaptic strength. Every synapse is shaped by original biological encoding/experiential encoding (**memory consolidation**) (what happened: what they saw, who held them, what frightened them, what they practiced, etc.)
  - **Memory reconsolidation**: how they interacted with/changed their original experience later (rewiring)
- **There is no normal brain template.** Functional connectivity patterns are individual enough that a person can be identified from their connectome, like a fingerprint (Finn et al., 2015). "Normal" is a statistical convenience, not a biological entity — nobody has the reference brain, because there isn't one.

Receptor distribution, not chemical quantity, is what differs between individuals.

Azevedo, F. A. C., et al. (2009). J. Comp. Neurol., 513(5), 532–541. · Finn, E. S., et al. (2015). Nat. Neurosci., 18(11), 1664–1671.

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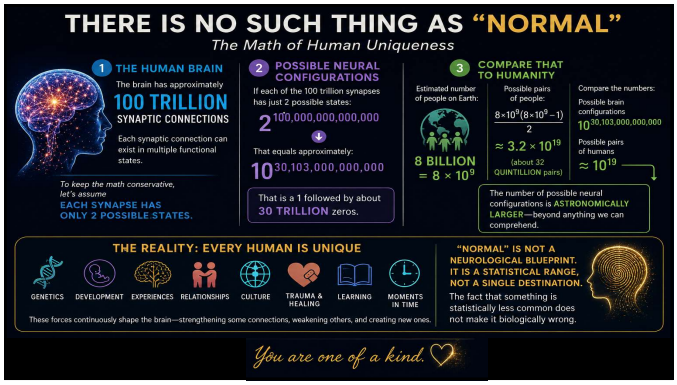

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What drives us?

1. Emotions are stored in motivational networks in the brain and engage organisms to respond to appetitive or aversive environments. (Wasserman & Wasserman, 2020).

2. Emotion is the "energization of behavior by, or the direction of behavior toward, positive stimuli (objects, events, possibilities), whereas avoidance motivation may be defined as the energization of behavior by, or the direction of behavior away from, negative stimuli (objects, events, possibilities)" (Monni et al., 2020, p. 2)

3. **E**lectrochemical signals that engage the body to take action (**-motion**) to approach or avoid internal or external stimuli that are of greatest value to the subject.

Wasserman & Wasserman (2020); Monni et al. (2020, p.2); Scherer, K. R. (2005). ; Barrett, L. F. (2017). Kashdan, T. B., Barrett, L. F., & McKnight, P. E. (2015); Lange et al., (2020); Moors, (2022)

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Integrated Theory from all emotion theories

1. That humans have distinct emotions that account for variations in emotions **within and between individuals**...

2. emotion components...
- **bidirectional** causal relationship with each other component
- each exist on an **encoded network**
- each elicits collective & varying responses

cognitions	interoception
motivations	valence
feelings	beliefs
facial expressions	hormones
appraisals	neurotransmitters
arousal	behaviors
meaning	consequences
propreoception	social influences

3. **E**lectrochemical signals that engage the body to take action (**-motion**) to approach or avoid internal or external stimuli that are of greatest value to the subject.

(Lange et al., 2020; Moors, 2022).

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DEFINITIONS MATTER

What "emotion" actually is — and WHY

Collective components of emotion

- **Encoded network -** biological/experiential
- **Stimulus -** internal/external cues
  - Expression - face, voice, posture, etc./culturally influenced (rules)
  - Butterflies/stomach ache
- **Cognitive appraisal (sometimes)** - e.g., subjective: label, narrative
  - valence (intensity) & salience (noticeability) (↑↓)
- **Motivation (Response/Action tendency) -** approach/avoid
  - Expression - face, voice, posture, etc./culturally influenced (rules)
- **Regulation (sometimes)** - actual threat/perceived threat

The brain encodes emotions; it doesn't detect them.

Emotions are not "feelings" (e.g., labels, sensations – conscious or subconscious)

Narratives/Appraisals are often <u>not</u> accurate - The same racing heart can become "anxious," "excited" or "furious" depending only on immediate appraisal.

Scherer, K. R. (2005). ; Barrett, L. F. (2017). Kashdan, T. B., Barrett, L. F., & McKnight, P. E. (2015); Lange et al., (2020); Moors, (2022)

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WHY THIS MATTERS

We respond to current situations using prior predictive encoding, not currently accurate content.

When defusing a bomb; the bomb squad must be trained first!

Your brain is a forecasting machine based in prior learning.
- It makes <u>guesses</u> based on prior encodings about what is happening and what to do.
- It doesn't check the guess for accuracy, until you teach it how.
- Experiential scripts supply the guesses
  - "Men are neanderthals who only think about sex" is a guess from prior learning that can change, literally, what you perceive on a man's face.
  - "Women are nags" is a guess from prior learning that drives your dismissal of a necessary complaint
- **Relationally, scripts are often self-confirming.** Because predictions shape behavior, expecting failure makes you push harder for correction, which produces failure, which confirms the prediction.
  - Fear of possible cheating→obsessive accusations of cheating→overwhelmed by accusations→eventually cheats (confirming prediction)

<u>Clinical implication</u>: correcting a bad understanding of how brains actually work in relationships is rescripting directly with the physically encoded network that is generating the script.

Barrett, L. F. (2017). Soc. Cogn. Affect. Neurosci., 12(1), 1–23. · Friston, K. (2010). Nat. Rev. Neurosci., 11(2), 127–138.

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Lets re-encode some networks!

- Women:
  "Men are neanderthals who only think about sex."
  - Testosterone level – 2.5 to 11x more than women
  - Women's lower level drives lower levels of arousal
- Men:
  "Women are nags."
  - 80% of complaints in relationships are brought up by women who, in general, are biologically and socially encoded to nurture relationships.
  - Men's engagement drives greater trust and connection

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Relational Emotion Myths

- **Emotion does not exist without motivation**
- **Every intact human nervous system runs on it!**
  - Emotion is not a female trait
  - Emotion is not a weakness
  - Is not an interruption to rational thought.
  - Men are not void of emotions.
  - It is a mechanism for both surviving & thriving
- What differs between genders is the culturally encoded definition and permissions to express themselves.
- Take emotion away (PFC dmage), you don't get Spock. You get catastrophically impaired decision-making.

Barrett, L. F. (2017). Soc. Cogn. Affect. Neurosci., 12(1), 1–23.

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MYTH 1 OF 16

"Women are just more emotional than men."

WHAT THE BRAIN ACTUALLY SAYS

It's like judging who's more athletic by asking who talks about the gym more.

Every component of the emotion process runs in every intact nervous system. Gender differences appear mainly in expression and self-report — the two components culture trains — and largely vanish when you measure physiology instead.

Emotional film clips:

- facial expression – women more expressive
- self-reported experience – modest differences
- physiological arousal – no meaningful difference in arousal responses
- **Children: Effect sizes very small but get steadily LARGER with age!**

Chaplin, T. M., & Aldao, A. (2013). Psychol. Bull., 139(4), 735–765. · Kring, A. M., & Gordon, A. H. (1998). J. Pers. Soc. Psychol., 74(3), 686–703.

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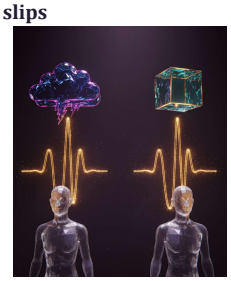
MYTH 1 · THE EVIDENCE

Same machinery, different permission slips

What actually differs — and what the difference costs both people in the room.

- **Social attribution differs more than emotion does – disposition vs situation**
  - woman's disposition ("she's emotional")
  - man's situation ("he's having a bad day").
- **Brain differences are small and overlapping -** most brains not male- or female-typical beyond size differences; few reliable differences.
- The cost:
  - women's emotion reads as instability, discrediting accurate perception;
  - men's reads as temporary, delaying help-seeking.



Kring & Gordon (1998). JPSP, 74(3), 686–703. · Chaplin & Aldao (2013). Psychol. Bull., 139(4), 735–765. · Barrett & Bliss-Moreau (2009). Emotion, 9(5), 649–658. · Joel et al. (2015). PNAS, 112(50), 15468–15473. · Eliot et al. (2021). Neurosci. Biobehav. Rev., 125, 667–697.

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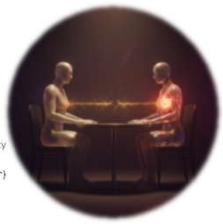
MYTH 1 · THE EVIDENCE, CONTINUED

Suppression of emotion impacts both parties

Studies showed that men's physiology matches women's while their expression does not — this is the mechanism behind that gap.



- **Study: Suppression raises autonomic load — and spreads it.**
  - hiding emotion successfully fooled observers while increasing sympathetic activation in the instructed suppressor.
  - blood pressure rose in the unsuspecting partner.
- **It degrades connection.**
  - Suppressors were rated less likeable and less responsive
  - partners lost interest in affiliating without knowing why.
    - Remove predictability in face and voice and the brain treats the ambiguity as threat.
- **Clinical translation:** parents talk differently to boys about emotion (less, more anger) and more with girls (more often, more sadness)
  - Not intentional, just different programming

A **mismatch** between what the network had originally encoded in prior learning.
Validation regulates; mismatch transforms. Both are needed for healing and serve different neurochemical functions.
- mismatch can change neural networks for better or worse according to perceived/encoded thriving/survival needs

Gross & Levenson (1997). J. Abnorm. Psychol., 106(1), 95–103. · Butler, E. A., et al. (2003). Emotion, 3(1), 48–67. · Fivush, R., et al. (2008). Sex Roles, 42, 233–253. · Aznar, A., & Tenenbaum, H. R. (2015). Br. J. Dev. Psychol., 33(1), 148–155.

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MYTH 2 OF 16

"She's overreacting. She's must be hormonal."

WHAT NEUROSCIENCE ACTUALLY SAYS

Everyone is hormonal, constantly
- Testosterone fluctuates on a daily cycle
- cortisol has a strong circadian rhythm in every human
- Ovarian hormones fluctuate across the menstrual cycle
  - estradiol modulates dopamine and serotonin signaling
  - progesterone acts on GABA receptors.
  - Premenstrual Dysphoric Disorder (PMDD)

Culturally: Attributing a woman's emotional responses to her endocrine system and a man's to his circumstances is a stereotype, not an endocrinology finding.

Romans, S., et al. (2012). Gender Med., 9(5), 361–384. · Barrett, L. F., & Bliss-Moreau, E. (2009). Emotion, 9(5), 649–658.

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MYTH 2 · THE EVIDENCE

"Hormonal" is not a mechanism. It's a discussion-ender.

Her: "I am sad about how our conflict has been."
Him: "You're just being hormonal."
Conversion: target was relationship, converted target to HER & impossible to discuss without evidence
Clinical implication: re-encoding that "he doesn't care about my concerns, doesn't like me," etc. vs. "I can trust that he will support my needs."

- **PMS/PMDD**
  - Study: suppression of ovarian hormone function, reintroduction of hormones. Women with PMS had symptoms return. Controls did not.
    - Same hormones, different sensitivities – not abnormal hormone levels

Romans, S., et al. (2012). Gender Med., 9(5), 361–384. · Schmidt, P. J., et al. (1998). N. Engl. J. Med., 338(4), 209–216. · Barrett & Bliss-Moreau (2009). Emotion, 9(5), 649–658.

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Love, attachment, and the myths that come true

Romantic love is not one thing. It is at least three separable systems with different chemistry, different timelines, and different failure modes — and most relationship despair comes from mistaking one for another.

Fisher, H. E., Aron, A., & Brown, L. L. (2005). J. Comp. Neurol.,493(1), 58–62. · Feldman, R. (2017). Trends Cogn. Sci., 21(2), 80–99.

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THE ARCHITECTURE

Three systems: Relationships are Neurochemical & Encoding

Helen Fisher's framework: lust, attraction, and attachment run on different chemistry and can operate independently. That independence explains a great deal of human misery.

Cultural Problems???
Which one is called LOVE???
Do other systems have value???

1 LUST
Testosterone, estrogen

- Non-specific sexual motivation. Directed at a category, not a person.
- Can be entirely present with no attraction or attachment
- Desire tells you almost nothing about compatibility.

2 ATTRACTION
Norepinephrine, Dopamine, low Serotonin

- Focused, obsessive, goal-seeking pursuit of ONE specific person (not just sex)
- Intrusive thoughts, reduced need for sleep, appetite change.
- Intensely irrational & motivational
- Time-limited by design: mildly stressful, metabolically expensive & unsustainable
  - Proximity
  - Employment
  - Risks other relationships
  - Safety

3 ATTACHMENT
Oxytocin, vasopressin, opioids

- Calm, secure territorial
- tolerance of proximity, distress w/ separation
- Co-regulation of stress physiology
- slow to build, slow to break.
- system that prevents lasting relationships

Fisher, H. E., Aron, A., & Brown, L. L. (2005). J. Comp. Neurol.,493(1), 58–62. · Aron, A., et al. (2005). J. Neurophysiol.,94(1), 327–337.

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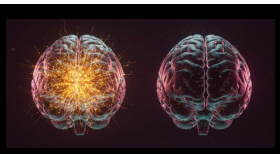
THE ANIMAL MODEL THAT CHANGED EVERYTHING

Two voles, one lesson: it's the receptors, not the chemical



The prairie vole is monogamous. The montane vole is emphatically not. They have similar hormones. What differs is where the receptors sit.

- **Receptor distribution, not hormone quantity.**
  - The difference is dense vasopressin receptors a reward region
  - Increased receptor expression in Montane Voles increased partner preference.
- **Bonding happens when a specific individual gets wired into your reward system** — not when you feel a lot.
- **Human caution.** lower pair-bonding scores in Swedish men a small study, not replicated elswhere.
- There is no monogamy gene:
  "We don't have chemistry" means **"my reward system hasn't learned this person yet."**

Young, L. J., & Wang, Z. (2004). Nat. Neurosci., 7(10), 1048–1054. · Lim, M. M., et al. (2004). Nature, 429(6993), 754–757. · Walum, H., et al. (2008). PNAS, 105(37), 14153–14156.

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MYTH 3 OF 16

"When you know, you know."

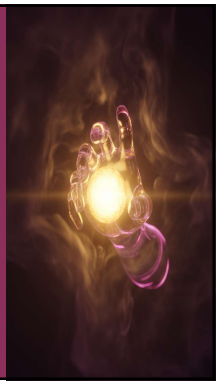
WHAT NEUROSCIENCE ACTUALLY SAYS

The certainty of early love is a dopaminergic state, not an assessment. It is generated by the same circuitry that makes uncertain rewards compelling — and it peaks precisely when you have the least information about the person.

More accurately:

- Dopaminergic firing encode predictability/significance
- Not knowing is what's generating the intensity
- Early love feels like "knowing certainty"

"When you actually know, you've been paying attention for a while."



Aron, A., et al. (2005). J. Neurophysiol., 94(1), 327–337. · Joel, S., et al. (2020). PNAS, 117(32), 19061–19071.

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MYTH 3 · THE EVIDENCE

What predicts whether your relationship goes well?

*Answer: **Who you pick matters much less than what you both build together.***

11,000 couples: **relationship-specific, not partner-specific**:

- perceived commitment
- Appreciation
- sexual satisfaction
- conflict frequency.
- **NOT**: their personality or traits, the stuff you agonize about when choosing

- **Objectivity: Family Systems:** No relationship fails because of one person. It's impacted by the patterns that exist between them.
  - It's us, not you
- **Accountability:** You can't change your partners contributions, only your own. Your changes force a change in the system
  - It's also me
- **Integration**
  - We-ness (Siegel)
- **Predictability teaches your partner trust**
  - Turning towards one another (Gottman)

Joel, S., et al. (2020). Machine learning uncovers the most robust self-report predictors of relationship quality across 43 longitudinal couples studies. PNAS, 117(32), 19061–19071.

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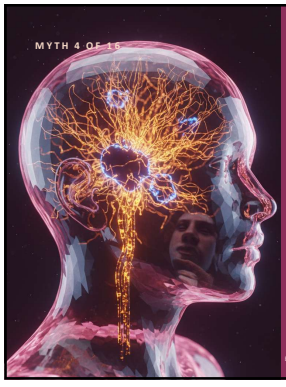

MYTH 4 OF 16

"Love is blind."

WHAT NEUROSCIENCE ACTUALLY SAYS

Closer to true than most of these — and it's a specific, measurable **deactivation**, not a metaphor. Romantic love reduces activity in regions used for social judgment and mentalizing about others. It isn't blindness. It's targeted suspension of scrutiny , so commitment can happen, and energy conservation to ensure survival.

- Same patterns exist for romantic and maternal love - evolution appears to deactivate encoding for the bonds it most wants protected.
- The cost: precisely the period when people make large, hard-to-reverse decisions — moving in, marrying, having children, merging finances.
  - Suppression of evaluative processing that flag early controlling behavior
- Everyone could see it but me" is not stupidity - their evaluative mechanisms are online

WHY?: Predictability reduces energy usage in the brain, Conscious thought uses a measurable increase in energy.

Bartels, A., & Zeki, S. (2004). NeuroImage, 21(3), 1155–1166. · Bartels, A., & Zeki, S. (2000). NeuroReport, 11(17), 3829–3834.

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MYTH 5 OF 16

"Opposites attract."

WHAT THE BRAIN ACTUALLY SAYS

They don't!

- The research against it is strong. Similarity predicts attraction, satisfaction, and stability across many studies.
- What we call "opposite" in a happy couple is usually complementary skill within broad similarity of values.
- Across millions of couples: similarities between partners across the overwhelming majority of traits studied: Education, substance use, political attitudes, height, even some health measures.
- Negative correlations were rare and small
- Differences get noticed: Nobody says "look at those two, they both like being on time." Noticeable gets mistaken for characteristic.
- Early opposition is novel (dopaminergic) – exciting is misread as compatibility.
- Complementarity can signal compatibility too. Fun vs grounded, planner vs flexible.

Montoya, R. M., Horton, R. S., & Kirchner, J. (2008). J. Soc. Pers. Relat., 25(6), 889–922. · Horwitz, T. B., et al. (2023). Nat. Hum. Behav., 7, 1568–1583.

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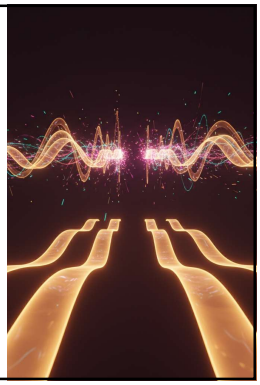
MYTH 5 · THE EVIDENCE

Why similarity is neurologically cheaper

It isn't that different people are worse. It's that difference imposes a continuous prediction cost.

The mechanism is prediction:

- A partner whose values, rhythms, and reactions resemble your own is easier to predict — fewer errors, less updating, lower metabolic load.
- Repeated unresolved prediction error registers as friction and then as threat; "I never know where I stand" describes a high-error model.
- Opposites can become predictable and lower metabolic load.



Horwitz, T. B., et al. (2023). Nat. Hum. Behav., 7, 1568–1583. · Montoya, R. M., et al. (2008). J. Soc. Pers. Relat., 25(6), 889–922. · Friston, K. (2010). Nat. Rev. Neurosci., 11(2), 127–138.

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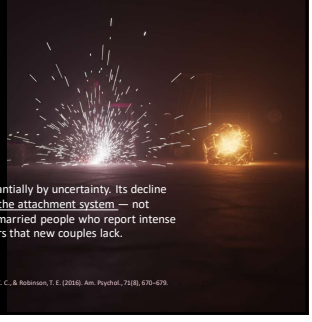
MYTH 6 OF 16

"Once the spark is gone, love is gone."



WHAT THE BRAIN ACTUALLY SAYS

The spark is a dopaminergic wanting/learning state driven substantially by uncertainty. Its decline is a normal, predictable transition from the attraction system to the attachment system — not evidence of failure, but evidence of uncertainty resolving! Long-married people who report intense love still show reward-system activation, plus attachment markers that new couples lack.

Acevedo, B. P., Aron, A., Fisher, H. E., & Brown, L. L. (2012). Soc. Cogn. Affect. Neurosci., 7(2), 145–159. · Berridge, K. C., & Robinson, T. E. (2016). Am. Psychol., 71(8), 670–679.

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MYTH 6 · THE EVIDENCE

Wanting, liking, and what actually maintains desire

If the spark is uncertainty-driven, then the practical question is not "how do we get it back?" but "what generates novelty that doesn't require insecurity?"

Novelty can be generated without instability.
- couples randomly assigned to novel, arousing shared activities reported greater relationship quality than those assigned merely pleasant ones.
- Shared arousal gets attributed to the partner — used deliberately, that is an intervention.

The unromantic truth:
- desire in long relationships is more responsive than spontaneous, so waiting to feel like it and treating its absence as diagnosis is the actual problem.
- Change systems – take responsive, not reactive action (more passion, more romance)

Focusing only on a faded spark ignores ways that couples still
- Connection through intention, curiosity, & vulnerability! - relearning

Acevedo, B. P., et al. (2012). SCAN, 7(2), 145–159. · Aron, A., et al. (2000). J. Pers. Soc. Psychol., 78(2), 273–284. · Dutton, D. G., & Aron, A. P. (1974). J. Pers. Soc. Psychol., 30(4), 510–517. · Berridge & Robinson (2016). Am. Psychol., 71(8), 670–679.

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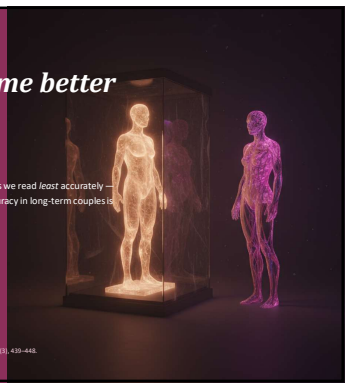
MYTH 7 OF 16

"A good partner knows me better than I know myself."

WHAT THE BRAIN ACTUALLY SAYS

Nobody can read minds, and the people closest to us are often the ones we read *least* accurately — because familiarity replaces observation with prediction. Empathic accuracy in long-term couples is modest and does not reliably improve with time.

One of the single most damaging features present in struggling relationship, alongside a lack of accountability (actual vs impression).



Ickes, W. (1993). J. Pers., 61(4), 587–610. · Kenny, D. A., & Acitelli, L. K. (2001). J. Pers. Soc. Psychol., 80(3), 439–448.

29

MYTH 7 · THE EVIDENCE

Familiarity replaces observation & curiosity with prediction

- People are more certain, and not more correct, about close others than strangers and your brain does not re-observe what it believes it already knows.

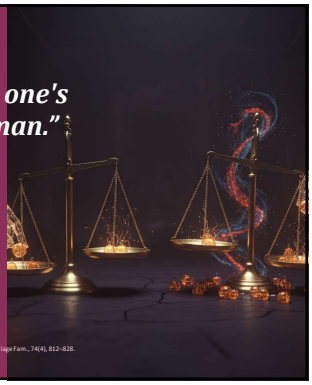
- Expected mind-reading makes the asking the evidence of failure
  - resentment accrues silently and the partner is convicted in a trial they never attended.
  - Mind reading becomes the assumed & inaccurate solution (**never happened, ever**)
  - Resentment is a result of not communicating about needs (and/or having a partner who is not available for it)

Ickes, W. (1993). J. Pers., 61(4), 587–610. · Kenny, D. A., & Acitelli, L. K. (2001). JPSP, 80(3), 439–448. · Savitsky, K., Keysar, B., Epley, N., Carter, T., & Swanson, A. (2011). J. Exp. Soc. Psychol., 47(1), 269–273.

30

MYTH 8 OF 16

"In every same-sex couple, one's the man and one's the woman."



WHAT THE BRAIN ACTUALLY SAYS

This assumes gendered relational roles are biologically assigned rather than culturally allocated. Same-sex couples, freed from default assignment, distribute labor and emotional roles more evenly and negotiate them explicitly — and report less conflict about the division.

Kurdek, L. A. (2007). J. Fam. Issues, 28(1), 132–148. · Goldberg, A. E., Smith, J. Z., & Perry-Jenkins, M. (2012). J. Marriage Fam., 74(4), 812–828.

31

MYTH 8 · THE EVIDENCE

What same-sex couples reveal about heterosexual ones

The natural experiment: remove default role assignment and see what remains

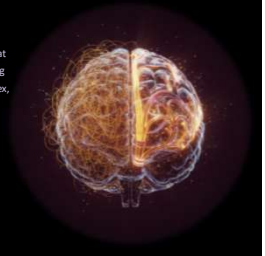
- **More equal division, better conflict process.** Kurdek (2007): same-sex couples divided household tasks and decision-making more evenly. Gottman et al. (2003): in lab conflict they **used more humor** and positive affect, escalated less physiologically, and took criticism less personally.
  - Humor is a biological bonding tool, not a personality trait — it triggers endorphins and neural synchrony
- **Roles are negotiated, not inherited**. With no cultural default, allocation has to be explicit — and that, not sexual orientation, is the mechanism. Goldberg et al. (2012) found less of the sharp gendered specialization that typically emerges after a first child.
- **Take-home for heterosexual couples:** satisfaction is broadly comparable across couple types, so this is not a claim that one group is better at love — it is a claim about what defaults cost. The advantage comes from saying it out loud, which anyone can adopt.

Kurdek, L. A. (2007). J. Fam. Issues, 28(1), 132–148. · Gottman, J. M., et al. (2003). J. Homosex., 45(1), 65–91. · Goldberg, A. E., et al. (2012). J. Marriage Fam., 74(4), 812–828.

32

3

The parent brain is built, not issued



Caregiving does not run on a female-only circuit that switches on at birth. It runs on a caregiving network that is activated by caregiving — and the strongest predictor of how strongly it activates is not sex, not gestation, and not genetic relatedness.

It is hours of hands-on care.

Hoekzema, E., et al. (2017). Nat. Neurosci., 20(2), 287–296. · Abraham, E., et al. (2014). PNAS, 111(27), 9792–9797.

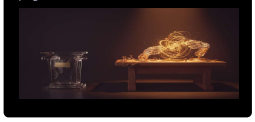
33

THE FINDING THAT REFRAMED EVERYTHING

Pregnancy causes measurable, long-lasting brain remodeling

2 years+

Duration of the gray matter changes Hoekzema's team could still detect after birth — and a machine-learning classifier could identify who had been pregnant from the scan alone.



- **Pregnancy remodels the brain.** group scanned women before conception, after birth, and at follow-up against matched controls including first-time fathers, finding substantial, consistent gray matter decreased in social-cognition and mentalizing regions.
- **Reduction is not damage.** The pattern resembles adolescent synaptic pruning (or editing) of weak connections. Changes persisted at six years postpartum (like clearing underbrush).
- **But note what this does NOT show -** that emodeling is required for good caregiving. Fathers, adoptive parents, and non-gestational parents reach comparable caregiving outcomes by a different route.

Hoekzema, E., et al. (2017). Nature Neuroscience, 20(2), 287–296. · Martínez-García, M., et al. (2021). Brain Sciences, 11(2), 168.

34

MYTH 9 OF 16

"A mother's instinct is something she's born with."

WHAT THE BRAIN ACTUALLY SAYS

The caregiving network is present in everyone and is activated by caregiving. Mothers are not issued a finished instinct — they build one, fast, under intense practice conditions. Which is precisely why it can be built by people who were never pregnant. Some mothers don't feel it immediately for various reasons.

Studies showed gray matter in specific regions *increased* across months postpartum – built by caretaking experience.

- Intense novel practice conditions
- Intense/continual survival dependency
- Lack of immediate maternal bonding is common (trauma, PPD, PPA, PPP, Unknown)
- Continues for months/years

Kim, P., et al. (2010). Behav. Neurosci., 124(5), 695–700. · Feldman, R. (2015). Trends Neurosci., 38(6), 387–399.

35

MYTH 9

Fathers get a parent brain too…testicular findings…

Testosterone drops in fathers.
- 600 men in the Philippines: those who became fathers showed significantly larger testosterone declines than those who did not,
- largest declines were in the most involved caregivers
- Endocrine change, not a social role

The body reallocates between mating effort and parenting effort.
- Study found men with smaller testes and lower testosterone showed greater brain activation when viewing their own child
- rated as more involved
- A state that shifts with caregiving, not a fixed male setting.

Oxytocin increases with paternal care.
- mothers and fathers across the postpartum period, with contact
  - mothers via affectionate touch
  - fathers via stimulatory play
  - Neither route is superior

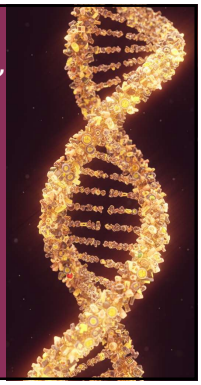
When someone says "he's just not a natural with the baby," what they very often mean is "he has fewer hours with the baby."

Gettler, L. T., et al. (2011). PNAS, 108(39), 16194–16199. · Mascaro, J. S., Hackett, P. D., & Rilling, J. K. (2013). PNAS, 110(39), 15746–15751. · Gordon, I., et al. (2010). Biol. Psychiatry, 68(4), 377–382.

36

MYTH 10 OF 16

"Every kid needs a mom and a dad."



WHAT THE BRAIN ACTUALLY SAYS

The caregiving network doesn't check the caregiver's sex. In same-sex parent families, the primary-caregiving parent shows the same amygdala activation pattern seen in primary-caregiving mothers — regardless of gestation or biological relatedness. And decades of outcome data show no disadvantage.

Children raised by same-sex parents performed BETTER on school outcomes than children raised by different-sex parents (partly explained by socioeconomic differences— same-sex parents were on average more educated and better resourced, which relates to the effort required to become a parent.

Abraham, E., et al. (2014). PNAS, 111(27), 9792–9797. · Crouch, S. R., et al. (2014). BMC Public Health, 14, 635.

37

4

The gut, the guess, and the limits of intuition

Your brain is not receiving reality. It is generating a prediction and correcting it with sensory data — including data from inside your own body.

That process produces feelings of certainty that are sometimes exquisitely accurate and sometimes catastrophically wrong, and — crucially — feel identical from the inside.

Barrett, L. F., & Simmons, W. K. (2015). Nat. Rev. Neurosci., 16(7), 419–429. · Kahneman, D., & Klein, G. (2009). Am. Psychol., 64(6), 515–526.

38

MECHANISM

Interoception: your brain is running a body budget

A "gut feeling" is a real signal. It is just not a signal about the thing you think it's about.

- **The brain runs a body budget, not a gauge.** It monitors heart rate, breathing, gut, blood chemistry and immune signals (Craig, 2002) — and predicts what the body will need so the body can adjust to meet it (Barrett & Simmons, 2015). That is allostasis.
- **Affect is the summary readout of that budget:** how pleasant or unpleasant, how activated or deactivated. Simple, continuous, always present. You can feel the balance but you cannot itemize it — you know you are in the red, not which transaction did it.
- **Which is exactly the problem.** Poor sleep, low blood sugar, an unresolved work conflict and a genuinely untrustworthy partner all produce the same unpleasant, activated readout. The brain then explains the feeling using whatever is most salient — affective realism.

Craig, A. D. (2002). Nat. Rev. Neurosci., 3(8), 655–666. · Barrett, L. F., & Simmons, W. K. (2015). Nat. Rev. Neurosci., 16(7), 419–429. · Seth, A. K. (2013). Trends Cogn. Sci., 17(11), 565–573.

39

MYTH 11 OF 16

"Always trust your gut."

WHAT THE BRAIN ACTUALLY SAYS

Intuition is pattern recognition. It is only as good as the patterns you've been able to learn — which requires a regular environment and rapid, reliable feedback. Most relationship decisions offer neither. Trusting your gut with no feedback loop is trusting a guess that has never been corrected.

Kahneman, D., & Klein, G. (2009). Am. Psychol., 64(6), 515–526. · Barrett, L. F., & Simmons, W. K. (2015). Nat. Rev. Neurosci., 16(7), 419–429.

40

MYTH 11 · THE EVIDENCE

When intuition is excellent and when it's a confident guess…

Intuition is a guess based on prior learning experience stored at the neural level.

1 Condition 1: Is the environment predictable?

Are there genuine, stable patterns available to learn?

✓ Chess. Firefighting. Reading an ECG. An experienced parent. A psychologist and a bad presidential candidate.

✗ Predicting a new partner will be a good spouse in 15 years.

People are predictable enough for short-range prediction and much less predictable across decades and major life transitions.

2 Condition 2: Was there fast, reliable feedback?

Did you get told, quickly and clearly, whether each judgment was right?

✓ The nurse who suspects a heart attack & finds out within minutes.

✗ You judged someone untrustworthy at a party in 2011 and never saw them again. You have no idea whether you were right. That judgment has never been corrected — and never will be.

Without feedback, confidence grows while accuracy does not.

3 So when SHOULD you trust it?

Trust it as data, not a verdict. A gut feeling is a genuine signal that your body budget has shifted. That is real information.

High trust: domains w/thousands of corrected guesses — an experienced clinician's sense that something is wrong with a patient.

Low trust: novel people, high stakes, cognitive biases, no feedback history, and any state where you are, tired, hungry, unwell, or emotionally activated.

Always ask: what else could be producing this readout right now?

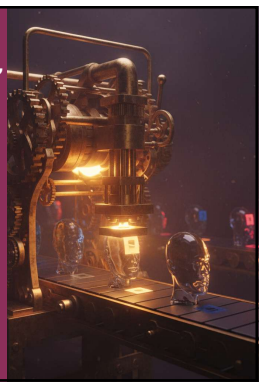
Kahneman, D., & Klein, G. (2009). Am. Psychol., 64(6), 515–526. · Dunn, B. D., et al. (2010). Psychol. Sci., 21(12), 1835–1844.

41

MYTH 12 OF 16

"I can read people like a book."

Or its cousins:
"I'm a really good judge of character."
"I knew immediately."



WHAT NEUROSCIENCE ACTUALLY SAYS

First impressions form in about 100 milliseconds, are highly reliable between observers, and are only weakly related to the traits they claim to detect. High agreement is not accuracy — it means we all share the same face-based stereotypes.

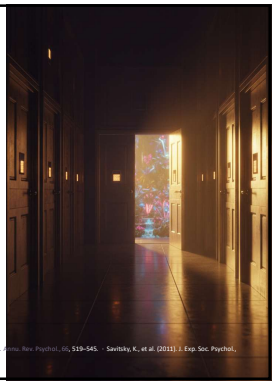
Willis, J., & Todorov, A. (2006). Psychol. Sci., 17(7), 592–598. · Todorov, A., et al. (2015). Annu. Rev. Psychol., 66, 519–545.

42

MYTH 12 · THE EVIDENCE

Fast, confident, consistent — and only loosely connected to reality

Judging faces: trustworthiness, competence, likeability, aggressiveness
- more time didn't improve judgement, time improved confidence
- Hundreds of people broadly agreed
  - evidence of accuracy vs common stereotype
  - algorithm is low
  - familiarity increases sense of predictability
- Feedback is the only things that improves this system
  - Pattern recognition requires feedback
  - Fear of failure limits integration of feedback



Willis, J., & Todorov, A. (2006). Psychol. Sci., 17(7), 592–598. · Todorov, A., Olivola, C. Y., Dotsch, R., & Mende-Siedlecki, P. (2015). Annu. Rev. Psychol., 66, 519–545. · Savitsky, K., et al. (2011). J. Exp. Soc. Psychol.,

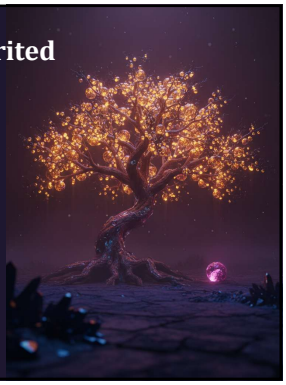
43

5

What you actually inherited

Genes do not encode personalities, tempers, or relationship styles. They encode proteins — and whether, when, and how much of a protein gets made depends heavily on the environment the organism is developing in.

Inheritance is real. It just doesn't work the way the family stories say.



Meaney, M. J. (2001). Annu. Rev. Neurosci., 24, 1161–1192. · Turkheimer, E. (2000). Curr. Dir. Psychol. Sci., 9(5), 160–164.

44

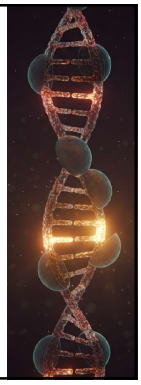
MECHANISM

A genetics is a recipe, not a blueprint

Genes are generationally, environmentally, experientially encoded, expressed, and changed.

- **Recipe, not blueprint.** A blueprint implies a fixed plan where deviation is error — that is how most people understand genes, and it is wrong. A recipe's output depends on ingredients, oven, altitude and cook: same recipe, reliably different cakes.
- **Genes code for proteins; proteins do everything else.** No temper gene, because a **temper is not a protein** — it is the outcome of thousands of interacting processes. Roughly the same gene set builds a liver cell and a neuron; what differs is which genes are expressed, when, and how much.
- **Environment determines the outcome of a cell.** Three cloned stem cells will grow according to the Petrie dish they are placed in: muscle, neuron, skin. Humans are bundles of cells. Environment always matters!
- **Heritability is widely misunderstood.** It is a population statistic — how much variation in a trait tracks genetic variation in that population, in that environment. It says nothing about an individual. Height is highly heritable in a well-fed population; introduce famine and it drops. The genes didn't change, the context did.

Turkheimer, E. (2000). Curr. Dir. Psychol. Sci., 9(5), 160–164. · Polderman, T. J. C., et al. (2015). Nat. Genet., 47(7), 702–709. Lipton, B. (2005)



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METAPHOR

Relationships are recipes built by couples.

- People in relationships are just the ingredients in a recipe.
- Remember, what's in the recipe matters much less than what those ingredients build together.
- When a relationship doesn't work out, it doesn't mean the ingredients were bad, it means it didn't work in the recipe.
- Pepper is a good ingredient, but it doesn't work well in cake!
- That same pepper may work excellent in some chicken alfredo!

46

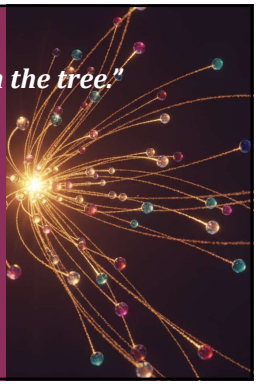
MYTH 13 OF 16

"The apple doesn't fall far from the tree."

WHAT THE BRAIN ACTUALLY SAYS

Siblings raised in the same home with 50% shared DNA are far less alike than the proverb implies. Most of the environmental variance that shapes personality is *non-shared* — the environment that differs between siblings inside the same family.

Children are not half mom & half dad. They have genetic makeup from generations before their parents were born and as soon as their senses form they begin encoding their networks. DON'T FORGET VARIABILITY!



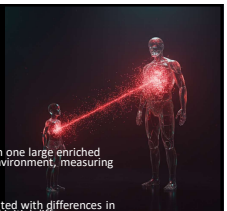
Plomin, R., & Daniels, D. (1987). Behav. Brain Sci., 10(1), 1–16. · Polderman, T. J. C., et al. (2015). Nat. Genet., 47(7), 702–709.

47

MYTH 14 · THE EVIDENCE

Even identical genes and identical environments produce different humans.

The most decisive experiment on this question was done in mice, and it is remarkable.



- **The design.** Freund et al. (2013) housed 40 genetically identical mice together in one large enriched enclosure and tracked each individually by transponder — same genes, same environment, measuring how much of the space each explored.
- **Behavior diverged progressively over three months,** and the divergence correlated with differences in adult hippocampal neurogenesis — more exploration, more new neurons. Small initial differences amplified themselves: explore slightly more, have slightly different experiences, change the brain, change the behavior again.
- **Individuality emerges from accumulating history,** not from genes and environment alone — even when both are held constant. For families: two siblings do not share an environment in any meaningful sense. They share an address. What they experience diverges from day one, and then amplifies.

Freund, J., et al. (2013). Emergence of individuality in genetically identical mice. Science, 340(6133), 756–759. · Plomin, R., & Daniels, D. (1987). Behav. Brain Sci., 10(1), 1–16.

48

MYTH 14 OF 16

"He gets that temper from his father."

"You act just like your mother."

WHAT THE BRAIN ACTUALLY SAYS

Genes do not encode personalities, tempers, behaviors, or relationship styles. Where genes do contribute, they contribute sensitivity to environment — not a behavior. Single-gene variant explanations for complex behavior have almost universally failed to replicate (e.g. serotonin transporter/depression).

Border, R., et al. (2019). Am. J. Psychiatry, 176(5), 376–387. · Weaver, I. C. G., et al. (2004). Nat. Neurosci., 7(8), 847–854.

49

Observational Learning

- A child in a house with an angry adult develops anger when overwhelmed (response is behavior) and/or a threat detection system (response is preparation).
- You never learn anything about yourself from somebody else. You learn about their interpretation of you.
- Youth, with lack of experiential encoding for emotional disagreement, results in encoding of similar beliefs and behaviors.

Bandura, et al., (1966)

50

6

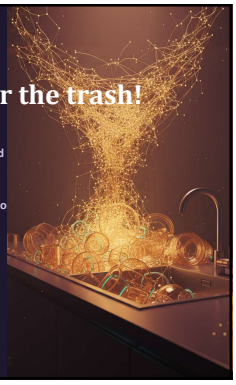
It's not about the dishes or the trash!

The most common presenting conflict in couples work in both the United States and Australia is domestic labor. It is also the conflict most confidently explained by appeals to biology — and the one where the biological evidence is thinnest.

Division of labor often comes up in the 1st session, pervades into the 10th…WHY?

- **Gendered emotion myth**
- **Mind-reading myth**
- **Parental brain myth**
- **Intuition myth**
- **Encultured gender roles myth**

PREDICTION ENCODING



Daminger, A. (2019). Am. Sociol. Rev., 84(4), 609–633. · Craig, L., & Mullan, K. (2011). Am. Sociol. Rev., 76(6), 834–861.

51

MYTH 15 OF 16

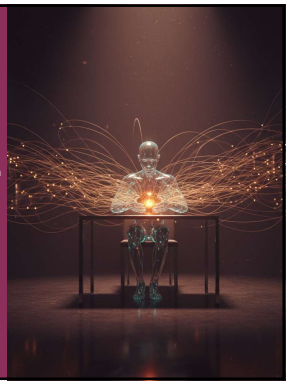
"He thinks I'm his mother." "She thinks she's my mom."

WHAT NEUROSCIENCE ACTUALLY SAYS

There is no reliable sex difference in multitasking performance. When tested directly with task-switching and dual-task paradigms, men and women show comparable costs. The belief is widely held — including by the people it disadvantages — and largely unsupported.

Truth:

- It's your encoding that says what you do/she does is what a mother does.
- This ignores integration in encoded prediction behaviors and builds nothing together.



Hirsch, P., Koch, I., & Karbach, J. (2019). PLOS ONE, 14(8), e0220150. · Szameitat, A. J., et al. (2015). PLOS ONE, 10(10), e0140371.

52

MYTH 15 · THE EVIDENCE

Cognitive labor doesn't show up in a time-use diary

Four components of cognitive household labor…

- anticipate, identify options, decide and monitor
  - anticipation and monitoring fell disproportionately to women
  - even in couples who described themselves as egalitarian and split visible tasks evenly.
- **Anticipation is expensive -** Noticing that milk runs out is not a task, it's a background process; never ends.
- **Monitoring is invisible -** checking that a delegated task happened is itself labor
  - "just ask me and I'll do it" relocates the task without relocating the expense.
- Visible tasks are observable & countable
- Cognitive labor is unobservable, so uncountable (invalidated), continuous energy expenditure
  - sustained monitoring occupies working memory continuously (measurable costs to attention and recovery)
- One person has evidence, one has a feeling

Both partners report honestly and still disagree.

- Fathers do proportionally more play & recreational care.
  - Flexible/Autonomous: trip to the park can move (different day, time, length, removed)
- Mothers do proportionally more physical, routine, and non-discretionary care.
  - Inflexible/Fixed deadlines: Bedtimes. School times. Child feeding. Mealtimes.

Perception is subjective, without integration in realities!

Daminger, A. (2019). The cognitive dimension of household labor. American Sociological Review, 84(4), 609–633. · Offer, S., & Schneider, B. (2011). Am. Sociol. Rev., 76(6), 809–833.

53

It's not about the trash; it's about the encoding!

Conflict is always a result of the topic being at least two different things!

Fights about the trash are never about the trash…

It's time…

The cognitive narrative: "I am too busy with everything I need to do."

The encoded network (Why time matters): "Because when I was growing up all my mom ever did was clean and never spent time with me. I don't want to be that type of mother."

It's money

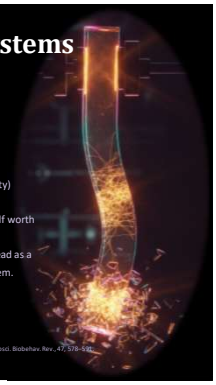
The cognitive narrative: "I don't want to spend so much on trash, trash bags, or another dumpster."

The encoded network (Why time matters): "I grew up poor and I never want to be poor again."

54

7

What trauma does to the systems love runs on.



Adversity does not simply leave bad memories. It retunes three systems that relationships depend on:

- Threat detection: **amygdala** responds to encoded experiences
- Safety learning: extinction is impaired & slow (low predictability of safety)
  - requires active (PFC & **hippocampus**), not reactivity
- Reward: reduced response too reward anticipation (anhedonia), low self worth

Each one produces a distinct relationship pattern. Each one is routinely misread as a character flaw by the person experiencing it and by the person living with them.

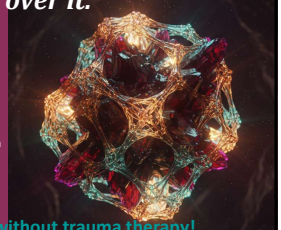
Teicher, M. H., & Samson, J. A. (2016). J. Child Psychol. Psychiatry, 57(3), 241–266. · McLaughlin, K. A., Sheridan, M. A., & Lambert, H. K. (2014). Neurosci. Biobehav. Rev., 47, 578–591.

55

MYTH 16 OF 16

"That was years ago. Just get over it."

"You need to let it go."
"You can't keep living in the past."
"At some point you have to choose to move on."
"IT'S ALL IN YOUR HEAD!"



WHAT NEUROSCIENCE ACTUALLY SAYS

"Getting over it" describes new learning (extinction/erasure) — an active, effortful process requiring intact prefrontal–hippocampal circuitry, delivered through repeated experiences of safety (extinction training) OR a **mismatch** in encoded predictability (prediction error - MR). It is not a decision, and it cannot be issued as an instruction. It's a physically encoded network that must be changed!

Why relationship therapy cannot exist without trauma therapy!

Milad, M. R., & Quirk, G. J. (2012). Annu. Rev. Psychol., 63, 129–151. · Herringa, R. J., et al. (2013). PNAS, 110(47), 19119–19124.

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MYTH 13 · THE EVIDENCE

What actually produces EXTINCTION — and what blocks it

- **Extinction is new learning, not erasure.** Spontaneous recovery, renewal and reinstatement all show the original association survives (Milad & Quirk, 2012) — safety is built on top of fear, not in place of it. It relies on vmPFC and hippocampus, the circuitry most affected by chronic stress and early maltreatment (Herringa et al., 2013). Extinction does not erase the original memory.
- **Avoidance is the main blocker.** Every avoided situation is a safety-learning trial that never ran, which is why fear persists in objectively safe environments for decades. Hence the cruellest pattern in relationships: the person who most needs repeated safe closeness is the one whose threat system makes closeness feel most dangerous.
- **What actually helps: predictability**, repetition, agency, and a partner who can tolerate being tested. Safety learned in a therapy room does not transfer automatically to another relationship — generalization is built deliberately. The partner's steadiness is not a personality trait here; it is the treatment protocol.

Milad, M. R., & Quirk, G. J. (2012). Annu. Rev. Psychol., 63, 129–151. · Herringa, R. J., et al. (2013). PNAS, 110(47), 19119–19124. · Jovanovic, T., & Ressler, K. J. (2010). Am. J. Psychiatry, 167(6), 648–662.

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TWO SYSTEMS AT A GLANCE

Memory Reconsolidation - ERASURE

Requirements

- Memory reactivation (brief, unlocking)
- Manipulation (mismatch)
  - Noticeable, Novel, Rewarding (dopaminergic increase)
- Time dependency
- Memory (network) specificity
- Dissociation of immediate & delayed effects

Mismatch = Prediction error

- A disagreement between what is expected and what occurs
- Emotional disagreement
- New emotional knowing (Ecker)
- Emotionally Learning I was wrong about what I knew before
- Increased dopaminergic response (electrochemical disagreement with prior learning)

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TWO SYSTEMS AT A GLANCE

Extinction & Erasure, side by side

EXTINCTION TRAINING

- **Run on predictability**
- **Repetition (exposure)**
- **Agency**
- **New learning creates new network**

MEMORY RECONSOLIDATION

- **Memory reactivation (firing)**
- **Memory specificity**
- **Mismatch (Prediction error)**
  - **New learning or connection to old learning**
  - **Rewrites original network**
- **Time dependency (5-hour window)**

BOTH ARE INHIBITED BY AVOIDANCE!!!

Hebbian Principle: Neurons that fire together wire together. Neurons that fire apart, wire apart.

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CLINICAL TRANSLATION

See the patterns, not just the people!

Relationship patterns are the problem

- **"He's so defensive" / "she won't let anything go."**
  - Threat detection tuned to false positives, and impaired safety learning.
  - Criticism (perceived attack) engages defense
- **"Nothing makes them happy"**
  - Blunted reward anticipation
- **"He explodes over nothing."**
  - threat detection plus norepinephrine + emotion vocabulary (size reflects physiological response, not the stimuli).
- **The common failure — "That's how little I am loved." vs. "He/she must be needing something too."**
- **Explanation is not obligation…that distinction protects both partners.**
- **Obligation to understand protects both partners** (persistence, not immediacy).
- **Being in a relationship with your impression of the other person is YOU in a relationship with yourself.**

Synthesizing Pollak & Sinha (2002); Milad & Quirk (2012); Dillon et al. (2009); Coan et al. (2006).

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What predicts whether your relationship goes well?

Your recipe, not just the ingredients!

- Integration
- Objectivity
- Accountability
- Predictability (trust)
- Vulnerability
- Tolerance/Understanding
- Communication
- Pattern awareness
- Change (re-encoding)
- Persistence, not immediacy
- Intentional design – there is NO NORMAL!

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THANK YOU

Love, Lies & Limbic Systems

Questions, please — in chat or unmuted.

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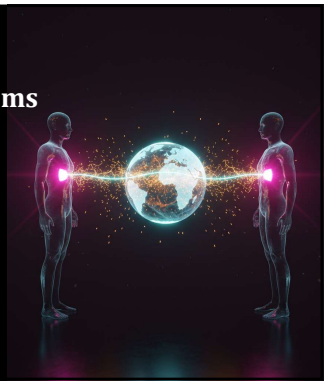
Reference slides follow.



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REFERENCES

References (1 of 5) — APA 7th edition

Abraham, E., Hendler, T., Shapira-Lichter, I., Kanat-Maymon, Y., Zagoory-Sharon, O., & Feldman, R. (2014). Father's brain is sensitive to childcare experiences. Proceedings of the National Academy of Sciences, 111(27), 9792–9797.

Acevedo, B. P., Aron, A., Fisher, H. E., & Brown, L. L. (2012). Neural correlates of long-term intense romantic love. Social Cognitive and Affective Neuroscience, 7(2), 145–159.

Aron, A., Fisher, H., Mashek, D. J., Strong, G., Li, H., & Brown, L. L. (2005). Reward, motivation, and emotion systems associated with early-stage intense romantic love. Journal of Neurophysiology, 94(1), 327–337.

Aron, A., Norman, C. C., Aron, E. N., McKenna, C., & Heyman, R. E. (2000). Couples' shared participation in novel and arousing activities and experienced relationship quality. Journal of Personality and Social Psychology, 78(2), 273–284.

Aznar, A., & Tenenbaum, H. R. (2015). Gender and age differences in parent–child emotion talk. British Journal of Developmental Psychology, 33(1), 148–155.

Azevedo, F. A. C., Carvalho, L. R. B., Grinberg, L. T., Farfel, J. M., Ferretti, R. E. L., Leite, R. E. P., Jacob Filho, W., Lent, R., & Herculano-Houzel, S. (2009). Equal numbers of neuronal and nonneuronal cells make the human brain an isometrically scaled-up primate brain. Journal of Comparative Neurology, 513(5), 532–541.

Bandura, A., Grusec, J. E., & Menlove, F. L. (1966). Observational learning as a function of symbolization and incentive set. Child development, 499-506.

Barrett, L. F. (2017). The theory of constructed emotion: An active inference account of interoception and categorization. Social Cognitive and Affective Neuroscience, 12(1), 1–23.

Barrett, L. F., & Bliss-Moreau, E. (2009). She's emotional. He's having a bad day: Attributional explanations for emotion stereotypes. Emotion, 9(5), 649–658.

Barrett, L. F., & Simmons, W. K. (2015). Interoceptive predictions in the brain. Nature Reviews Neuroscience, 16(7), 419–429.

Bartels, A., & Zeki, S. (2000). The neural basis of romantic love. NeuroReport, 11(17), 3829–3834.

Bartels, A., & Zeki, S. (2004). The neural correlates of maternal and romantic love. NeuroImage, 21(3), 1155–1166.

Berridge, K. C., & Robinson, T. E. (2016). Liking, wanting, and the incentive-sensitization theory of addiction. American Psychologist, 71(8), 670–679.

Bianchi, S. M., Sayer, L. C., Milkie, M. A., & Robinson, J. P. (2012). Housework: Who did, does or will do it, and how much does it matter? Social Forces, 91(1), 55–63.

Bick, J., Dozier, M., Bernard, K., Grasso, D., & Simons, R. (2013). Foster mother–infant bonding: Associations between foster mothers' oxytocin production, electrophysiological brain activity, feelings of commitment, and caregiving quality. Child Development, 84(3), 826–840.

Border, R., Johnson, E. C., Evans, L. M., Smolen, A., Berley, N., Sullivan, P. F., & Keller, M. C. (2019). No support for historical candidate gene or candidate gene-by-interaction hypotheses for major depression across multiple large samples. American Journal of Psychiatry, 176(5), 376–387.

Bos, H. M. W., Knox, J. R., van Rijn-van Gelderen, L., & Gartrell, N. K. (2016). Same-sex and different-sex parent households and child health outcomes: Findings from the National Survey of Children's Health. Journal of Developmental & Behavioral Pediatrics, 37(3), 179–187.

Butler, E. A., Egloff, B., Wilhelm, F. H., Smith, N. C., Erickson, E. A., & Gross, J. J. (2003). The social consequences of expressive suppression. Emotion, 3(1), 48–67.

Caspi, A., Sugden, K., Moffitt, T. E., Taylor, A., Craig, I. W., Harrington, H., McClay, J., Mill, J., Martin, J., Braithwaite, A., & Poulton, R. (2003). Influence of life stress on depression: Moderation by a polymorphism in the 5-HTT gene. Science, 301(5631), 386–389.

Chaplin, T. M., & Aldao, A. (2013). Gender differences in emotion expression in children: A meta-analytic review. Psychological Bulletin, 139(4), 735–765.

Coan, J. A., Schaefer, H. S., & Davidson, R. J. (2006). Lending a hand: Social regulation of the neural response to threat. Psychological Science, 17(12), 1032–1039.

63

REFERENCES

References (2 of 5) — APA 7th edition

Craig, A. D. (2002). How do you feel? Interoception: The sense of the physiological condition of the body. Nature Reviews Neuroscience, 3(8), 655–666.

Craig, L., & Mullan, K. (2011). How mothers and fathers share childcare: A cross-national time-use comparison. American Sociological Review, 76(6), 834–861.

Crouch, S. R., Waters, E., McNair, R., Power, J., & Davis, E. (2014). Parent-reported measures of child health and wellbeing in same-sex parent families: A cross-sectional survey. BMC Public Health, 14, 635.

Daminger, A. (2019). The cognitive dimension of household labor. American Sociological Review, 84(4), 609–633.

De Dreu, C. K. W., Greer, L. L., Van Kleef, G. A., Shalvi, S., & Handgraaf, M. J. J. (2011). Oxytocin promotes human ethnocentrism. Proceedings of the National Academy of Sciences, 108(4), 1262–1266.

Del Giudice, M., Lippa, R. A., Puts, D. A., Bailey, D. H., Bailey, J. M., & Schmitt, D. P. (2016). Joel et al.'s method systematically fails to detect large, consistent sex differences. Proceedings of the National Academy of Sciences, 113(14), E1965.

Dillon, D. G., Holmes, A. J., Birk, J. L., Brooks, N., Lyons-Ruth, K., & Pizzagalli, D. A. (2009). Childhood adversity is associated with left basal ganglia dysfunction during reward anticipation in adulthood. Biological Psychiatry, 66(3), 206–213.

Dunn, B. D., Galton, H. C., Morgan, R., Evans, D., Oliver, C., Meyer, M., Cusack, R., Lawrence, A. D., & Dalgleish, T. (2010). Listening to your heart: How interoception shapes emotion experience and intuitive decision making. Psychological Science, 21(12), 1835–1844.

Dutton, D. G., & Aron, A. P. (1974). Some evidence for heightened sexual attraction under conditions of high anxiety. Journal of Personality and Social Psychology, 30(4), 510–517.

Eisenberger, N. I., Lieberman, M. D., & Williams, K. D. (2003). Does rejection hurt? An fMRI study of social exclusion. Science, 302(5643), 290–292.

Eliot, L., Ahmed, A., Khan, H., & Patel, J. (2021). Dump the "dimorphism": Comprehensive synthesis of human brain studies reveals few male–female differences beyond size. Neuroscience & Biobehavioral Reviews, 125, 667–697.

Farr, R. H., Forssell, S. L., & Patterson, C. J. (2010). Parenting and child development in adoptive families: Does parental sexual orientation matter? Applied Developmental Science, 14(3), 164–178.

Feldman, R. (2015). The adaptive human parental brain: Implications for children's social development. Trends in Neurosciences, 38(6), 387–399.

Feldman, R. (2017). The neurobiology of human attachments. Trends in Cognitive Sciences, 21(2), 80–99.

Felitti, V. J., Anda, R. F., Nordenberg, D., Williamson, D. F., Spitz, A. M., Edwards, V., Koss, M. P., & Marks, J. S. (1998). Relationship of childhood abuse and household dysfunction to many of the leading causes of death in adults: The Adverse Childhood Experiences (ACE) Study. American Journal of Preventive Medicine, 14(4), 245–258.

Finn, E. S., Shen, X., Scheinost, D., Rosenberg, M. D., Huang, J., Chun, M. M., Papademetris, X., & Constable, R. T. (2015). Functional connectome fingerprinting: Identifying individuals using patterns of brain connectivity. Nature Neuroscience, 18(11), 1664–1671.

Fisher, H. E., Aron, A., & Brown, L. L. (2005). Romantic love: An fMRI study of a neural mechanism for mate choice. Journal of Comparative Neurology, 493(1), 58–62.

Fivush, R., Brotman, M. A., Buckner, J. P., & Goodman, S. H. (2000). Gender differences in parent–child emotion narratives. Sex Roles, 42(3–4), 233–253.

Freund, J., Brandmaier, A. M., Lewejohann, L., Kirste, I., Kritzler, M., Krüger, A., Sachser, N., Lindenberger, U., & Kempermann, G. (2013). Emergence of individuality in genetically identical mice. Science, 340(6133), 756–759.

Friston, K. (2010). The free-energy principle: A unified brain theory? Nature Reviews Neuroscience, 11(2), 127–138.

64

REFERENCES

References (3 of 5) — APA 7th edition

Gettler, L. T., McDade, T. W., Feranil, A. B., & Kuzawa, C. W. (2011). Longitudinal evidence that fatherhood decreases testosterone in human males. Proceedings of the National Academy of Sciences, 108(39), 16194–16199.

Goldberg, A. E., Smith, J. Z., & Perry-Jenkins, M. (2012). The division of labor in lesbian, gay, and heterosexual new adoptive parents. Journal of Marriage and Family, 74(4), 812–828.

Gordon, I., Zagoory-Sharon, O., Leckman, J. F., & Feldman, R. (2010). Oxytocin and the development of parenting in humans. Biological Psychiatry, 68(4), 377–382.

Gottman, J. M., Levenson, R. W., Swanson, C., Swanson, K., Tyson, R., & Yoshimoto, D. (2003). Observing gay, lesbian and heterosexual couples' relationships: Mathematical modeling of conflict interaction. Journal of Homosexuality, 45(1), 65–91.

Gross, J. J., & Levenson, R. W. (1997). Hiding feelings: The acute effects of inhibiting negative and positive emotion. Journal of Abnormal Psychology, 106(1), 95–103.

Gunnar, M., & Quevedo, K. (2007). The neurobiology of stress and development. Annual Review of Psychology, 58, 145–173.

Herringa, R. J., Birn, R. M., Ruttle, P. L., Burghy, C. A., Stodola, D. E., Davidson, R. J., & Essex, M. J. (2013). Childhood maltreatment is associated with altered fear circuitry and increased internalizing symptoms by late adolescence. Proceedings of the National Academy of Sciences, 110(47), 19119–19124.

Hirsch, P., Koch, I., & Karbach, J. (2019). Putting a stereotype to the test: The case of gender differences in multitasking costs in task-switching and dual-task situations. PLOS ONE, 14(8), e0220310.

Hochschild, A., & Machung, A. (2012). The second shift: Working families and the revolution at home (Rev. ed.). Penguin Books.

Hoekzema, E., Barba-Müller, E., Pozzobon, C., Picado, M., Lucco, F., García-García, D., Soliva, J. C., Tobeña, A., Desco, M., Crone, E. A., Ballesteros, A., Carmona, S., & Vilarroya, O. (2017). Pregnancy leads to long-lasting changes in human brain structure. Nature Neuroscience, 20(2), 287–296.

Horwitz, T. B., Balbona, J. V., Paulich, K. N., & Keller, M. C. (2023). Evidence of correlations between human partners based on systematic reviews and meta-analyses of 22 traits and UK Biobank analysis of 133 traits. Nature Human Behaviour, 7, 1568–1583.

Ickes, W. (1993). Empathic accuracy. Journal of Personality, 61(4), 587–610.

Joel, D., Berman, Z., Tavor, I., Wexler, N., Gaber, O., Stein, Y., Shefi, N., Pool, J., Urchs, S., Margulies, D. S., Liem, F., Hänggi, J., Jäncke, L., & Assaf, Y. (2015). Sex beyond the genitalia: The human brain mosaic. Proceedings of the National Academy of Sciences, 112(50), 15468–15473.

Joel, S., Eastwick, P. W., Allison, C. J., Arriaga, X. B., Baker, Z. G., Bar-Kalifa, E., … Wolf, S. (2020). Machine learning uncovers the most robust self-report predictors of relationship quality across 43 longitudinal couples studies. Proceedings of the National Academy of Sciences, 117(32), 19061–19071.

Jovanovic, T., & Ressler, K. J. (2010). How the neurocircuitry and genetics of fear inhibition may inform our understanding of PTSD. American Journal of Psychiatry, 167(6), 648–662.

Kahneman, D., & Klein, G. (2009). Conditions for intuitive expertise: A failure to disagree. American Psychologist, 64(6), 515–526.

Kandel, E. R., Koester, J. D., Mack, S. H., & Siegelbaum, S. A. (Eds.). (2021). Principles of neural science (6th ed.). McGraw Hill.

Kashtan, T. B., Barrett, L. F., & McKnight, P. E. (2015). Unpacking emotion differentiation: Transforming unpleasant experience by perceiving distinctions in negativity. Current Directions in Psychological Science, 24(1), 10–16.

Kenny, D. A., & Acitelli, L. K. (2001). Accuracy and bias in the perception of the partner in a close relationship. Journal of Personality and Social Psychology, 80(3), 439–448.

Kim, P., Leckman, J. F., Mayes, L. C., Feldman, R., Wang, X., & Swain, J. E. (2010). The plasticity of human maternal brain: Longitudinal changes in brain anatomy during the early postpartum period. Behavioral Neuroscience, 124(5), 695–700.

65

REFERENCES

References (4 of 5) — APA 7th edition

Kinnaird, E., Stewart, C., & Tchanturia, K. (2019). Investigating alexithymia in autism: A systematic review and meta-analysis. European Psychiatry, 55, 80–89.

Kring, A. M., & Gordon, A. H. (1998). Sex differences in emotion: Expression, experience, and physiology. Journal of Personality and Social Psychology, 74(3), 686–703.

Kross, E., Berman, M. G., Mischel, W., Smith, E. E., & Wager, T. D. (2011). Social rejection shares somatosensory representations with physical pain. Proceedings of the National Academy of Sciences, 108(15), 6270–6275.

Kurdek, L. A. (2007). The allocation of household labor by partners in gay and lesbian couples. Journal of Family Issues, 28(1), 132–148.

Lange, J., Dalege, J., Borsboom, D., van Kleef, G. A., & Fischer, A. H. (2020). Toward an integrative psychometric model of emotions. Perspectives on Psychological Science, 15(2), 444-468. https://doi.org/10.1177%2F1745691619895057

Levant, R. F., Hall, R. J., Williams, C. M., & Hasan, N. T. (2009). Gender differences in alexithymia. Psychology of Men & Masculinity, 10(3), 190–203.

Lim, M. M., Wang, Z., Olazábal, D. E., Ren, X., Terwilliger, E. F., & Young, L. J. (2004). Enhanced partner preference in a promiscuous species by manipulating the expression of a single gene. Nature, 429(6993), 754–757.

Lipton, B. H. (2016). The biology of belief 10th anniversary edition: Unleashing the power of consciousness, matter & miracles. Hay House, Inc.

Marazziti, D., Akiskal, H. S., Rossi, A., & Cassano, G. B. (1999). Alteration of the platelet serotonin transporter in romantic love. Psychological Medicine, 29(3), 741–745.

Martínez-García, M., Paternina-Die, M., Desco, M., Vilarroya, O., & Carmona, S. (2021). Do pregnancy-induced brain changes reverse? The brain of a mother six years after parturition. Brain Sciences, 11(2), 168.

Mascaro, J. S., Hackett, P. D., & Rilling, J. K. (2013). Testicular volume is inversely correlated with nurturing-related brain activity in human fathers. Proceedings of the National Academy of Sciences, 110(39), 15746–15751.

Mazrekaj, D., De Witte, K., & Cabus, S. (2020). School outcomes of children raised by same-sex parents: Evidence from administrative panel data. American Sociological Review, 85(5), 830–856.

McLaughlin, K. A., Sheridan, M. A., & Lambert, H. K. (2014). Childhood adversity and neural development: Deprivation and threat as distinct dimensions of early experience. Neuroscience & Biobehavioral Reviews, 47, 578–591.

Meaney, M. J. (2001). Maternal care, gene expression, and the transmission of individual differences in stress reactivity across generations. Annual Review of Neuroscience, 24, 1161–1192.

Milad, M. R., & Quirk, G. J. (2012). Fear extinction as a model for translational neuroscience: Ten years of progress. Annual Review of Psychology, 63, 129–151.

Monni, A., Olivier, E., Morin, A. J. S., Belardinelli, M. O., Mulvihill, K., & Scalas, L. F. (2020). Approach and avoidance in Gray's, Higgins', and Elliot's perspectives: A theoretical comparison and integration of approach-avoidance in motivated behavior. Personality and Individual Differences, 166, 110163. https://doi.org/10.1016/j.paid.2020.110163

Montoya, R. M., Horton, R. S., & Kirchner, J. (2008). Is actual similarity necessary for attraction? A meta-analysis of actual and perceived similarity. Journal of Social and Personal Relationships, 25(6), 889–922.

Moors, A. (2022). Old Wine in New Bags—Suri and Gross's connectionist theory of emotion is another type of network theory. Emotion Review, 14(2), 111-113. https://doi.org/10.1177/17540739221089689

Nave, G., Camerer, C., & McCullough, M. (2015). Does oxytocin increase trust in humans? A critical review of research. Perspectives on Psychological Science, 10(6), 772–789.

Nelson, C. A., Zeanah, C. H., Fox, N. A., Marshall, P. J., Smyke, A. T., & Guthrie, D. (2007). Cognitive recovery in socially deprived young children: The Bucharest Early Intervention Project. Science, 318(5858), 1937–1940.

Offer, S., & Schneider, B. (2011). Revisiting the gender gap in time-use patterns: Multitasking and well-being among mothers and fathers in dual-earner families. American Sociological Review, 76(6), 809–833.

Plomin, R., & Daniels, D. (1987). Why are children in the same family so different from one another? Behavioral and Brain Sciences, 10(1), 1–16.

Polderman, T. J. C., Benyamin, B., de Leeuw, C. A., Sullivan, P. F., van Bochoven, A., Visscher, P. M., & Posthuma, D. (2015). Meta-analysis of the heritability of human traits based on fifty years of twin studies. Nature Genetics, 47(7), 702–709.

Pollak, S. D., & Sinha, P. (2002). Effects of early experience on children's recognition of facial displays of emotion. Developmental Psychology, 38(5), 784–791.

66

REFERENCES

References (5 of 5) — APA 7th edition

Romans, S., Clarkson, R., Einstein, G., Petrovic, M., & Stewart, D. (2012). Mood and the menstrual cycle: A review of prospective data studies. Gender Medicine, 9(5), 361–384.

Savitsky, K., Keysar, B., Epley, N., Carter, T., & Swanson, A. (2011). The closeness-communication bias: Increased egocentrism among friends versus strangers. Journal of Experimental Social Psychology, 47(1), 269–273.

Schmidt, P. J., Nieman, L. K., Danaceau, M. A., Adams, L. F., & Rubinow, D. R. (1998). Differential behavioral effects of gonadal steroids in women with and in those without premenstrual syndrome. New England Journal of Medicine, 338(4), 209–216.

Seery, M. D., Holman, E. A., & Silver, R. C. (2010). Whatever does not kill us: Cumulative lifetime adversity, vulnerability, and resilience. Journal of Personality and Social Psychology, 99(6), 1025–1041.

Seth, A. K. (2013). Interoceptive inference, emotion, and the embodied self. Trends in Cognitive Sciences, 17(11), 565–573.

Shamay-Tsoory, S. G., & Abu-Akel, A. (2016). The social salience hypothesis of oxytocin. Biological Psychiatry, 79(3), 194–202.

Szameitat, A. J., Hamaida, Y., Tulley, R. S., Saylik, R., & Otermans, P. C. (2015). "Women are better than men" — Public beliefs on gender differences and other aspects in multitasking. PLOS ONE, 10(10), e0140171.

Teicher, M. H., & Samson, J. A. (2016). Annual research review: Enduring neurobiological effects of childhood abuse and neglect. Journal of Child Psychology and Psychiatry, 57(3), 241–266.

Teicher, M. H., Samson, J. A., Anderson, C. M., & Ohashi, K. (2016). The effects of childhood maltreatment on brain structure, function and connectivity. Nature Reviews Neuroscience, 17(10), 652–666.

Todorov, A., Olivola, C. Y., Dotsch, R., & Mende-Siedlecki, P. (2015). Social attributions from faces: Determinants, consequences, accuracy, and functional significance. Annual Review of Psychology, 66, 519–545.

Tottenham, N., Hare, T. A., Quinn, B. T., McCarry, T. W., Nurse, M., Gilhooly, T., ... Casey, B. J. (2010). Prolonged institutional rearing is associated with atypically large amygdala volume and difficulties in emotion regulation. Developmental Science, 13(1), 46–61.

Turkheimer, E. (2000). Three laws of behavior genetics and what they mean. Current Directions in Psychological Science, 9(5), 160–164.

Walum, H., Westberg, L., Henningsson, S., Neiderhiser, J. M., Reiss, D., Igl, W., ... Lichtenstein, P. (2008). Genetic variation in the vasopressin receptor 1a gene (AVPR1A) associates with pair-bonding behavior in humans. Proceedings of the National Academy of Sciences, 105(37), 14153–14156.

Wasserman, T., & Wasserman, L. (2020). Motivation potential is not motivation in action. In Motivation, Effort, and the Neural Network Model, 85-91. Springer, Cham.

Weaver, I. C. G., Cervoni, N., Champagne, F. A., D'Alessio, A. C., Sharma, S., Seckl, J. R., Dymov, S., Szyf, M., & Meaney, M. J. (2004). Epigenetic programming by maternal behavior. Nature Neuroscience, 7(8), 847–854.

Willis, J., & Todorov, A. (2006). First impressions: Making up your mind after a 100-ms exposure to a face. Psychological Science, 17(7), 592–598.

Yehuda, R., Daskalakis, N. P., Bierer, L. M., Bader, H. N., Klengel, T., Holsboer, F., & Binder, E. B. (2016). Holocaust exposure induced intergenerational effects on FKBP5 methylation. Biological Psychiatry, 80(5), 372–380.

Young, L. J., & Wang, Z. (2004). The neurobiology of pair bonding. Nature Neuroscience, 7(10), 1048–1054.

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