| LOG ID | BOOK REFERENCE | RCT FILTER | CONFIDENCE TIER |
|---|---|---|---|
| SEC 4.1.1 | CHAPTER 4: SECURITY AUDITING (Shadow Work) | ON | CONSENSUS |

AUDITED CLAIM

# DEPRECATION PROTOCOL (UPDATE THREAT LIBRARY)

SYSTEMS MODEL — AS STATED IN THE BOOK

> **Update the Threat Library:** Slowly update the system's threat-detection libraries to prove to the physical hardware that the environment is **safe today**. This allows the obsolete survival script to gracefully deprecate itself.

VALIDATION QUERY

Does exposing the nervous system to environmental cues of safety facilitate the extinction of trauma-based physiological threat responses?

EMPIRICAL FINDING

Neurobiological conditioning studies demonstrate that exposing the nervous system to environmental safety cues facilitates the **extinction** of trauma-related physiological threat responses. This effect is robust when cues support **new safety learning**, helping to overwrite the failure to recall extinction memory.

PRIMARY ANCHORS

→ **Milad et al., 2009, Biological Psychiatry**

→ **Garfinkel et al., 2014, The Journal of Neuroscience**

ABOUT THIS RECORD

Each claim in the book is decompiled from its IT metaphor into a naked, falsifiable scientific claim, then anchored to a **primary peer-reviewed source**. Claim and anchor are queried against the Consensus academic database (200M+ papers) under a fixed protocol — top-tier **Q1/Q2 journals only**, preprints excluded, human studies only. If a hypothesis fails the audit, the build is rejected: the AI generates the syntax; the peer-reviewed grid validates the physics.

CONFIDENCE TIERS

- **CONSENSUS ◀ this log** — broadly established, highly replicated mechanics.
- **EMERGING** — plausible, actively researched; no universal consensus yet.
- **EXPERIMENTAL** — contested, extrapolated, or purely theoretical.

**RCT FILTER** — Controlled Studies is ON for interventions (a forced action must beat a control) and OFF for mechanisms (so foundational neuroscience isn't blocked).

## THE DREAM MACHINE

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You are complex biological hardware running outdated psychological software. *The Dream Machine* translates rigorous IT architecture — security auditing, network protocols, load balancing — into actionable, peer-reviewed models for mental resilience: debug burnout, configure a hallucination firewall against cognitive distortions, and patch your internal OS with hard logic and verified neuroscience.

INITIATE SYSTEM UPDATE

Ready to debug your own source code? Scan to access the cybernetic manual and reboot your cognitive architecture today. → **dreammachine.systems**

Yes, **environmental safety cues** often **facilitate extinction** of trauma-related physiological threat responses, but effects are context-dependent.

## 1. Introduction

Exposing the nervous system to environmental cues of safety does appear to facilitate the extinction of trauma-based physiological threat responses, but the effect is reliable mainly when “safety” supports new learning rather than functioning as avoidance. Across this literature, trauma and PTSD are consistently linked to poorer discrimination of danger from safety, slower extinction, and weaker recall of extinction memory, which makes safety cue processing a central target rather than a peripheral one (Milad et al., 2009; Garfinkel et al., 2014; Jovanović et al., 2010). Healthy and resilient groups generally use contextual or social safety information to suppress conditioned threat, whereas PTSD groups often fail to do so or need stronger differentiation before safety-related brain processes come online ( Garfinkel et al., 2014; Kaczkurkin et al., 2016; Wicking et al., 2016).

The strongest support comes from experiments showing that learned safety, social support, and direct-plus-vicarious social safety exposure reduce recovery or return of fear, alongside translational studies where better safety learning predicts better exposure-based treatment outcomes ( Pan et al., 2020; Gong et al., 2025; Adolph et al., 2022). But the literature also shows important limits: safety behaviors can protect fear from extinction, stress can strip cues of their safety-signaling value, and some pharmacologic attempts to enhance safety/extinction in the clinic have failed despite promising laboratory data ( Wong & Pittig, 2020; Merz et al., 2020; Maples-Keller et al., 2019).

**Does exposing the nervous system to environmental cues of safety facilitate the extinction of trauma-based physiological threat responses?**

N = 15


Yes 80% · Possibly 7% · Mixed 7% · No 7%

FIGURE 1 Consensus on safety cues and trauma-related extinction

The meter should be read as a qualified yes. The corpus supports facilitation of extinction by safety cues under controlled conditions, but also shows that trauma, stress, and maladaptive safety behavior can blunt, reverse, or clinically complicate that effect (Michopoulos et al., 2017; Pan et al., 2020; Wong & Pittig, 2020).

## 2. Methods

The search ran across more than 170 million research papers indexed in Consensus, including Semantic Scholar, PubMed, and related sources. The workflow identified 38,298 initially relevant controlled human papers, then expanded through targeted deep-search queries on fear extinction, safety learning, contextual modulation, threat generalization, and translational interventions. After machine-assisted screening of 240 papers, 112 unique papers passed relevance thresholding, and the top 50 were included for this synthesis.

### Search Strategy

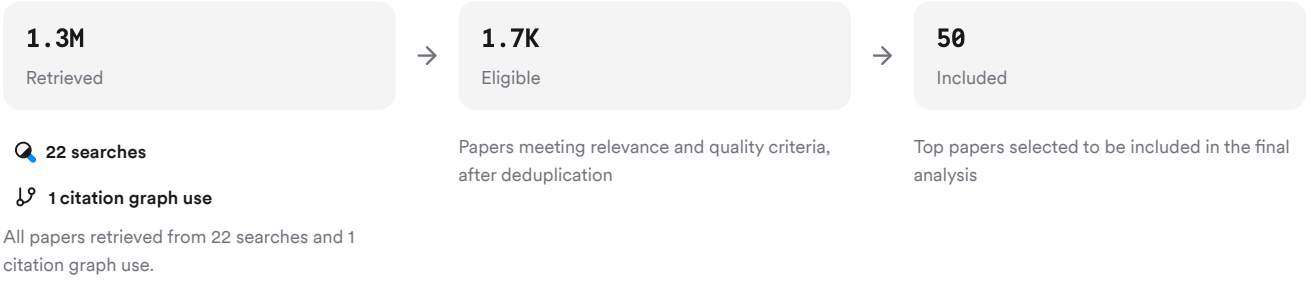


FIGURE 2 Paper identification and screening strategy

Searches combined foundational, translational, developmental, mechanistic, and boundary-condition queries focused on safety learning, extinction, and trauma physiology.

## 3. Results

### 3.1 Key Papers

Several papers anchor this corpus because they directly test whether safety context, extinction memory, or safety-signal processing are altered in PTSD. Milad et al. established the neurobiological signature of impaired extinction recall in PTSD, Garfinkel et al. showed impaired contextual modulation of safety versus danger memories, and Jovanović et al. demonstrated that deficient fear inhibition to safety cues is specific to PTSD rather than depression (Milad et al., 2009; Garfinkel et al., 2014; Jovanović et al., 2010).

| Paper | Summary |
|---|---|
| ( Zhou et al., 2025) | Impaired extinction recall in PTSD (Milad et al., 2009) |
| (Milad et al., 2009) | Safety context fails to suppress fear ( Garfinkel et al., 2014) |
| (Vizeli et al., 2022) | Fear inhibition deficit marks PTSD (Jovanović et al., 2010) |

FIGURE 3 Foundational papers in PTSD extinction research

### 3.2 Context and Safety Learning

| Dimension | PTSD or Trauma-Affected Groups | Controls or Resilient Groups | Citations |
|---|---|---|---|
| Safety context use | Poor suppression in safe context | Appropriate context-based suppression | ( Garfinkel et al., 2014) |
| Extinction recall | Higher autonomic and neural fear return | Better recall of extinction memory | (Wicking et al., 2016; Milad et al., 2009) |
| Danger-safety discrimination | Reduced differentiation | Clear differentiation | (Steiger et al., 2015; Glover et al., 2011) |
| Safety processing threshold | More dissimilarity needed before safety processes engage | Safety processes engage earlier | (Kaczkurkin et al., 2016) |
| Youth trauma effects | Poor differentiation during recall despite intact acquisition | More adaptive approach behavior | (Marusak et al., 2020) |

Across studies, trauma exposure does not always impair initial acquisition, but often disrupts later use of safety information during recall, generalization, or contextual modulation (Marusak et al., 2020; Milad et al., 2009). This pattern supports the idea that safety cues help when they can be encoded and retrieved, but trauma-based disorders weaken that process.

### 3.3 Social and Pharmacologic Facilitation

Direct social support before extinction reduced threat response, prevented return of threat memories, and remained detectable at two-week follow-up ( Gong et al., 2025). Shared social safety learning, combining direct exposure with another person's safety behavior, abolished threat recovery more effectively than asocial exposure ( Pan et al., 2020). Vicarious extinction delivered inside the reconsolidation window also prevented recovery of the reactivated fear memory ( Golkar et al., 2017).

| Feature | Result |
|---|---|
| Study type | Randomized human social-support experiment ( Gong et al., 2025) |
| Population | 96 completed three-day retention tests ( Gong et al., 2025) |
| Intervention | Friend interaction before extinction ( Gong et al., 2025) |
| Primary outcome | Reduced threat response and return ( Gong et al., 2025) |
| Durability | Long-lasting effect at two weeks ( Gong et al., 2025) |
| Neural correlate | Inhibited hippocampus, thalamus, precuneus ( Gong et al., 2025) |

FIGURE 4 Social support effects on extinction retention

Pharmacologic facilitation is more mixed. **Dexamethasone** reversed extinction and safety-discrimination deficits in laboratory PTSD paradigms (Michopoulos et al., 2017), but did not improve virtual-reality exposure outcomes and increased dropout in a small clinical trial (Maples-Keller et al., 2019). **MDMA** improved some extinction measures in one SCR-based crossover study and increased the proportion of healthy participants who retained extinction in another trial, but effects were measure-dependent and not consistently seen on startle outcomes (Vizeli et al., 2022; Maples-Keller et al., 2022).

### 3.4 Boundary Conditions

Safety cues are not uniformly beneficial. When safety takes the form of avoidance behavior, it can preserve threat beliefs by attributing the absence of harm to the behavior rather than to true safety, thereby blocking extinction learning ( Wong & Pittig, 2020). A small analogue study found that safety signals present during extinction did not interfere with later fear reduction, suggesting that not all safety cues are harmful and that implementation matters (Restrepo-Castro et al., 2017).

Stress is a major moderator. Acute stress reduced the safety-signaling value of out-group CS− cues during reinstatement and promoted generalized responding toward cues that should have remained safe ( Merz et al., 2020). Sleep-related findings are also nuanced: greater REM sleep predicted faster early extinction in trauma-exposed samples and lower conditioned fear at recall across healthy participants, but direct drug-based REM enhancement did not yet improve recall in a small pilot trial ( Richards et al., 2021; Schenker et al., 2025).

### Results Timeline

Research has moved from documenting extinction deficits to testing ways to enhance safety learning and retention.

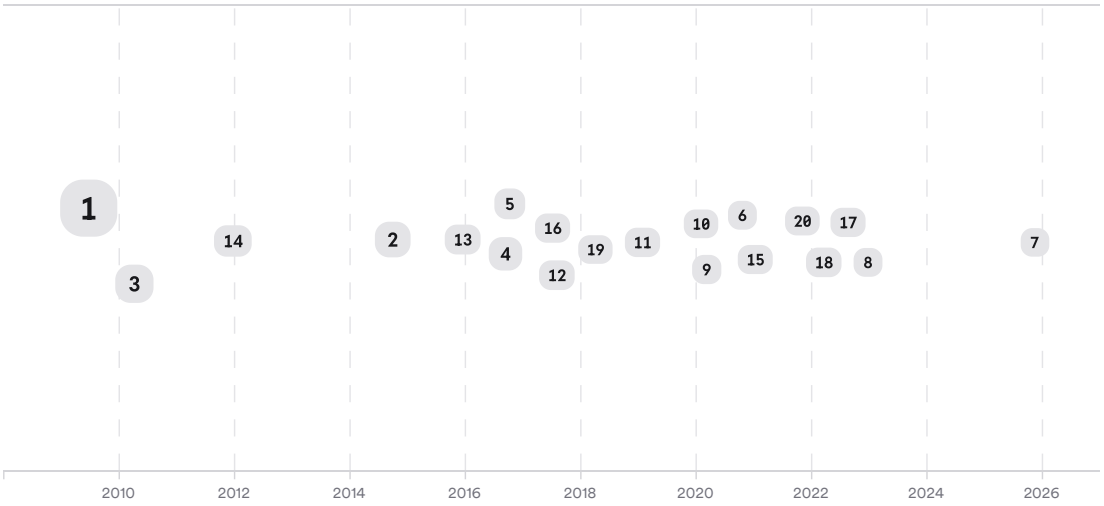


FIGURE 5 Timeline of fear extinction research, larger markers indicate more citations

The overall arc shows strong early evidence that PTSD disrupts extinction and safety discrimination, followed by newer work on social support, sleep, neuromodulation, and developmental moderators (Peri et al., 2000; Milad et al., 2009; ■ Gong et al., 2025).

**Top Contributors**

| Type | Name | Papers |
|---|---|---|
| Author | T. Jovanović | [595cf4ba841d59fb8b4d7ed2e0746258][654220402f8f5d2f8836f9bd066ec090] [76dd591490c95fa0a67fa1ee6360d0e2][c797a8576a3d587c97a29e5e9713c02e] [e936bda3db9a5523b828f780c6dc0bb9][209af11295cc54efaf038c79b7f6a07d] |
| Author | S. Norrholm | [72001b492d7f584fa11e18b3583a0a66][595cf4ba841d59fb8b4d7ed2e0746258] [654220402f8f5d2f8836f9bd066ec090][76dd591490c95fa0a67fa1ee6360d0e2] [c797a8576a3d587c97a29e5e9713c02e][e936bda3db9a5523b828f780c6dc0bb9] [209af11295cc54efaf038c79b7f6a07d] |
| Author | H. Flor | [f5173986fb8755a0a3c32c8170968d43][c11742dc715e51348d9fbe9bac46d719] [8aa7746c522959e6b75bbd14521bbee7][1673b7561ed4597a86640946e39400ee] [d9aa8ffc531b596e9d180548581c3995] |
| Journal | *Behaviour Research and Therapy* | [72001b492d7f584fa11e18b3583a0a66][173f536531ae5260ac7b8053619f1b78] [4d14cf9db5e05cb5a4ba346770f12f8a][d5637512372152ada3ead155a00d3d99] [9c7c458c5a6e50fdb56c9312f032d341][30c0a4b888e058e3af8703968e134d7a] |
| Journal | *Psychophysiology* | [c11742dc715e51348d9fbe9bac46d719][696f8daed73f533c8bbce68dd10ef3fc] [1673b7561ed4597a86640946e39400ee] |
| Journal | *Biological Psychiatry* | [bef2ed23fb1d53b4ac123da456cd11fa][34ba3964a8a65d39bfabe74257ff8624] [e936bda3db9a5523b828f780c6dc0bb9] |

FIGURE 6 Authors and journals appearing most often

## 4. Discussion

The best-supported conclusion is that safety-related environmental information can facilitate extinction, but the mechanism matters. Studies of contextual safety, conditioned inhibition, social support, and vicarious safety converge on reduced physiological threat expression or reduced return of fear when safety information is encoded as new learning rather than used as a shield from exposure ( Kribakaran et al., 2024; Gong et al., 2025). This is especially important in PTSD, where deficits repeatedly cluster around safety discrimination, contextual modulation, and extinction recall rather than simple acquisition alone (Steiger et al., 2015; Michopoulos et al., 2017; Van Rooij et al., 2014).

The corpus is strongest in controlled laboratory paradigms using FPS, SCR, and fMRI, with replication across adults, veterans, women, and youth (Peri et al., 2000; Glover et al., 2012; Kribakaran et al., 2024). But direct clinical translation remains incomplete. Some mechanistically promising interventions, including dexamethasone, FAAH inhibition, and CBD, did not reliably improve therapy outcomes or extinction enhancement in patient samples (Maples-Keller et al., 2019; Mayo et al., 2025; Kwee et al., 2023). The field also distinguishes beneficial **safety signals** from maladaptive **safety behaviors**, because the latter can reduce expectancy violation and sustain fear ( Wong & Pittig, 2020).

The broader implication is that “safe environment” interventions are likely to help most when they improve discrimination, contextual retrieval, or social buffering without allowing avoidance to replace learning. For personal treatment decisions, a licensed clinician should weigh how any safety-focused strategy is implemented, because helpful safety learning and counterproductive safety behavior are not the same phenomenon.

| Claim | Evidence Strength | Reasoning | Papers |
|---|---|---|---|
| Environmental safety information can reduce conditioned threat and support extinction retention. | Strong | Replicated across contextual, social, and vicarious paradigms, with physiological and neural outcomes. | ( Pan et al., 2020; Gong et al., 2025; Garfinkel et al., 2014) |
| PTSD is marked by impaired use of safety cues and extinction recall. | Strong | Strong replication across startle, SCR, behavior, and fMRI studies. | (Milad et al., 2009; Jovanović et al., 2010; Peri et al., 2000) |
| Social support is a promising safety-based extinction enhancer. | Moderate | Human experiments show reduced return of fear, but the literature is still small. | ( Pan et al., 2020; Gong et al., 2025) |
| Pharmacologic enhancement of safety/extinction is mixed in humans. | Moderate | Some lab benefits, inconsistent across measures, and weak clinical translation. | (Michopoulos et al., 2017; Maples-Keller et al., 2019; Mayo et al., 2025) |
| Safety behavior during exposure improves extinction. | Weak | Evidence instead suggests excessive safety behavior can block or weaken extinction. | ( Wong & Pittig, 2020) |

FIGURE 7 Key claims and supporting evidence

## 5. Conclusion

Across this corpus, the answer is yes: exposing the nervous system to cues of safety often facilitates extinction of trauma-based physiological threat responses. The effect is clearest for contextual safety, learned safety signals, and social support that strengthen retrieval of safety memory, and less reliable when trauma, stress, sleep disruption, or avoidance interfere with that process ( Kribakaran et al., 2024; Richards et al., 2021; Merz et al., 2020).

### Research Gaps

The main gaps are comparative efficacy, durability in clinical PTSD, and clear separation of beneficial safety learning from avoidance-like safety behavior.

| Topic/Outcome | Human RCTs | Clinical PTSD | Long-Term Follow-Up | Mechanistic Imaging |
|---|---|---|---|---|
| Contextual safety cues | 4 | 3 | 1 | 5 |
| Social support during extinction | 3 | 1 | 1 | 2 |
| Safety signal learning in youth | 2 | 1 | 1 | 3 |
| Pharmacologic augmentation | 5 | 4 | 2 | 2 |
| Safety behavior vs safety signal | 2 | GAP | 1 | GAP |

### Open Research Questions

Direct comparative tests are now the most useful next step.

| Question | Why |
|---|---|
| **Do social support cues enhance exposure therapy in PTSD better than standard extinction alone?** | Social support shows durable laboratory effects, but direct clinical augmentation trials in PTSD are still scarce. |
| **When do safety cues help learning versus become avoidance-like safety behaviors?** | This distinction likely determines whether safety reduces fear durably or preserves it through reduced expectancy violation. |
| **Can sleep-focused interventions improve safety-signal recall and extinction retention after trauma?** | REM-related findings are promising, but interventional evidence remains preliminary and inconsistent across drug and sleep designs. |

In short, environmental cues of safety usually help extinguish trauma-related physiological threat responses when they deepen safety learning rather than substitute for it.



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