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Review Article

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Biological Mechanism of Imagery Rescripting Psychological Intervention: A Critical Review

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ABSTRACT

Imagery Rescripting (IR) has become a widely used intervention for modifying aversive autobiographical memories across different psychological disorders. However, the underlying biological mechanisms of this approach remain unclear. This critical review synthesizes recent studies from the past five years that offer emerging insight into biological processes potentially relevant to this intervention. The reviewed findings highlight a fragmented but promising pattern pointing toward distributed biological pathways that may support IR's therapeutic effects. Evidence suggests that IR may engage multiple biological systems implicated in emotional processing, memory updating and reconsolidation, and more recently, interpersonal regulation. Limitations of the studies include the use of non-clinical samples and brief intervention protocols. The review concludes that future research must directly measure neural, physiological, and interpersonal responses during complete IR procedures using autobiographical material to clarify its specific biological mechanisms.

Keywords: Imagery Rescripting, Biological Mechanisms, Aversive Autobiographical Memory, Memory Updating, Memory Reconsolidation, Emotion Processing.

Background

Imagery Rescripting (IR) is a therapeutic technique widely used to address aversive memories in various psychological disorders [1]. IR involves guiding individuals to retrieve an aversive or traumatic memory with its associated sensory, emotional, cognitive, and somatic components, and then imagine altering the course of events toward a more desirable outcome that meets the individual's unmet needs [2,3]. The technique has been applied across disorders such as post-traumatic stress disorder (PTSD), depressive disorder, social anxiety disorder, specific phobias, body dysmorphic disorder, bulimia nervosa, obsessive-compulsive disorder, nightmares, and some personality disorders [2,3]. The clinical value of IR is supported by growing evidence demonstrating its capacity to reduce distress and reappraise the meanings associated with aversive experiences [4].

Although the technique is typically described in psychological terms, IR is fundamentally rooted in processes thought to reflect memory reconsolidation and updating. When an aversive autobiographical memory is reactivated during IR, its original sensory and emotional representations become labile, creating an opportunity for modification. By introducing new imagery that provides safety, protection, or agency, IR is theorized to integrate corrective information into the reactivated memory trace, reducing its emotional impact and "encapsulated beliefs" [2,3]. To understand the potential biological correlates of these mechanisms, it is essential to review the foundations of mental imagery research and its neurobiological basis, particularly in relation to memory and emotion, which provide context for the limited but emerging empirical work on IR's biological mechanisms.

Mental Imagery as a Therapeutic Tool

Mental imagery refers to the ability to generate internal sensory representations involving one or multiple senses in the absence of external stimuli [3,5,6]. Although imagery can involve any sensory modality, visual imagery is most common [3]. Imagery functions as part of healthy psychological processes, helping with tasks such as problem solving and recalling past experiences. Individuals vary in imagery vividness, and some lack visual

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imagery altogether, a condition referred to as aphantasia [3,5,7]. Imagery can be generated voluntarily, such as when recalling autobiographical events, solving problems or imagining future scenarios, but it can also occur involuntarily, as with intrusive images [3].

Historically, imagery was used as a healing practice by shamanic cultures over 20,000 years ago [8]. In contemporary psychotherapy, imagery has been integrated into psychodynamic, humanistic, and cognitive-behavioral therapies [6]. Within CBT, Wolpe introduced imagery in the 1950s as part of imaginal desensitization, and behavioral psychologists later adapted imagery for imaginal flooding, exposure, and extinction procedures [9]. Aaron Beck further integrated imagery into cognitive therapy by recognizing that images evoke emotional responses similar to verbal cognitions [6,10]. Jeffrey Young incorporated imagery into schema-focused therapy, drawing from the "healing scripts" technique in transactional analysis, and IR was first formally documented in 1995 [3]. Since then, IR has developed into a key technique used in multiple treatment modalities.

Mental Imagery in Experimental Psychology

Interest in mental imagery in experimental psychology dates back to the 19th century [9]. A major turning point occurred with Peter Lang's bio- informational theory in 1977-1979, which proposed that imagery activates emotional and physiological responses similar to those elicited by actual stimuli, making it a powerful vehicle for emotional change [3,9]. Subsequent studies have demonstrated that imagery evokes changes in heart rate, skin conductance responses, respiratory shifts, startle blink reflexes, gustatory salivation, satiation effects, pupillary dilation, and facial muscle activation [9,11,12]. Consistent evidence also supports concordance between subjective and physiological emotional responses during imagery [9].

Neuroimaging research has shown that imagining emotional material activates brain regions similar to those engaged during real perception, including the dorsomedial prefrontal cortex (dmPFC), anterior cingulate cortex (ACC), amygdala, insula, and nucleus accumbens [9]. Emotional imagery also activates the supplementary motor area and Default Mode Network regions such as the medial prefrontal cortex (mPFC), angular gyrus, anterior hippocampus, and lateral temporal cortex [11,13].

Although perception and visual imagery share overlapping brain networks, current evidence suggests that they rely on partially distinct mechanisms. Spagna et al. reported that early visual cortices were not strongly active during imagery, whereas frontoparietal regions and the left fusiform gyrus showed prominent involvement [5]. Trullo et al. identified overlapping regions in both scene perception and imagery, specifically the occipital area, parahippocampal area, retrosplenial complex (RSC), and hippocampus, but found that perception follows a bottom-up flow from occipital areas, whereas imagery follows a top-down flow originating in memory- related regions such as the hippocampus [14]. These findings highlight the role of higher- order networks in imagery, with the RSC serving as a central hub in both processes.

Regarding autobiographical memory, research points to a distributed network associated with episodic construction. Gurguryan et al. found that autobiographical recall involves the hippocampus, ventromedial prefrontal cortex (vmPFC), and posterior cingulate cortex (PCC), each engaged during different aspects of retrieval [15]. The anterior hippocampus supports initial construction, the posterior hippocampus elaborates details, the vmPFC contributes conceptual organization, and the PCC integrates sensory-perceptual features. Repeated retrieval of episodic and emotional autobiographical memories is associated with reduced activity in the anterior hippocampus and vmPFC, suggesting increased efficiency or decreased novelty [15,16].

Other studies have identified the frontoparietal and occipital regions as being involved in memory interference and updating. Specifically, the inferior parietal lobe, dorsolateral prefrontal cortex, dorsolateral anterior cingulate, and frontoparietal networks are activated during interference, while the occipital fusiform gyrus is activated during updated memories [17]. These findings provide a neurobiological foundation for processes that could underlie IR, such as memory modification and sensory integration.

Additionally, sleep research has also shown implication in different stages in emotional memory consolidation. Slow-wave sleep reinforces emotional content and promotes retention, while REM sleep may weaken emotional memories through selective elimination and contribute to memory transformation by forming new associations [18]. Sleep spindles have been linked to the consolidation of emotional memory, suggesting a biological route through which IR-related changes may be stabilized [18].

Problem Statement

While several imaginal techniques such as imaginal exposure, flooding, extinction and EMDR also use aversive memories as therapeutic content, IR is distinct in actively modifying the memory's content and outcomes. Instead of habituating to the distressing memory or emotional intensity, IR creates an altered narrative that addresses unmet needs and restores a more adaptive representation. This distinction highlights the importance of identifying biological mechanisms specific to memory modification and updating, as opposed to those supporting exposure-based learning.

Although IR is widely used and theoretically grounded in CBT, no studies have directly assessed its biological mechanisms. To address this gap, the following critical review examines seven studies from 2021 to 2025 that collectively provide emerging and indirect evidence relevant to IR's biological correlates. The studies primarily examine adjacent domains, including neural activation, sleep and memory processes, psychophysiological and neurophysiological markers, and emerging alternative interpersonal-neurobiological insights. Each study is synthesized and then reviewed.

Critical Review

Brain Activation Correlates

Aarts et al. investigated whether psychological treatment for PTSD, with or without comorbid personality disorder, produced measurable changes in brain activation during an emotional face-matching task [19]. They recruited 38 participants who

completed 3T fMRI scans before and after trauma-focused treatment (TFT; n = 22) or an integrated trauma- and personality-focused treatment (TFT+PT; n = 16). TFT consisted of 12–18 sessions of eye movement desensitization reprocessing (EMDR) or IR, while the integrated condition included these approaches plus group-based dialectical behavioral therapy (DBT) or schema therapy (ST). Brain activation was assessed using an emotional face-matching task that involved fearful, angry, neutral, and scrambled faces, and clinical outcomes were measured using psychological assessments.

The authors hypothesized that activation in the amygdala, dorsal anterior cingulate cortex (ACC), insula, and ventromedial prefrontal cortex (vmPFC) would decrease following treatment in both conditions, with larger changes expected in the TFT+PT group. They also predicted that changes in task-related activation would correlate with improvements in PTSD symptoms, emotion regulation, depression, and dissociation. Contrary to expectations, no significant pre–post treatment differences emerged across emotion-processing regions for the full sample, nor were there differences between treatment conditions. However, individuals classified as treatment responders showed greater reductions in bilateral ventromedial prefrontal cortex (vmPFC) activation, and this reduction was associated with decreased PTSD symptoms in the TFT group.

The study contributes some neuroimaging data in which IR was part of the intervention, providing an initial indication that the associated reduction in vmPFC activation may accompany clinical improvement. Because the vmPFC is involved in emotion regulation and emotional autobiographical memory retrieval, and is theorized to support processes aligned with IR, such as reducing affective distress or altering emotional meaning, the observed reductions offer indirect relevance to IR's proposed mechanisms [11,13].

At the same time, several aspects limit the specificity of their findings. Because IR and EMDR were part of the trauma-focused condition and results were not isolated for each intervention, changes cannot be attributed to IR alone. The emotional face- matching task may not sufficiently approximate the autobiographical content that IR targets, reducing the likelihood of detecting IR specific neural modulation. Without tasks involving memory retrieval, vmPFC reductions could reflect habituation rather than memory updating. Given that vmPFC activity naturally decreases across repeated retrieval, the findings may capture general processes rather than mechanisms linked specifically to IR.

Sleep and memory mechanisms

A recent line of experimental work conducted by Azza et al. has examined whether sleep can enhance the adaptive reconsolidation of aversive autobiographical memories following therapeutic interventions that target memory updating [20]. Their study included 44 university students, who underwent a standardized 50-minute IR session and were then randomly assigned either to a 90-minute nap or an equivalent period of wakefulness. IR required participants to recall an emotionally aversive personal memory, mentally re-experience it, and then elaborate an alternative, less distressing narrative in order to shift maladaptive interpretations and reduce negative affect.

Across pre-intervention, immediate post-intervention, and one-week follow-up assessments, the researchers collected subjective ratings of arousal, emotions, and dysfunctional cognitions, as well as physiological responses, indexed by heart rate. The findings indicated that imagery rescripting alone reduced emotional distress, but those who napped showed additional short-term benefits, including fewer dysfunctional cognitions and lower heart rate responses to the negative memory script immediately after the retention interval. However, these enhancements were not sustained at the one-week follow-up, suggesting that the sleep-related effects may be transient.

Notably, central sleep spindle density during the nap correlated with reductions in heart rate reactivity, consistent with broader evidence implicating sleep spindles in memory reconsolidation. This study offers preliminary support for the idea that sleep may augment IR therapeutic mechanisms, although the durability of these effects and their applicability to clinical populations remain unclear and warrant further investigation.

However, some limitations temper the conclusions. The brief benefits limit understanding of longer-term biological effects, and the healthy university sample restricts generalizability to clinical populations with more entrenched aversive autobiographical memories. Additionally, the study used a single 50-minute IR session, which may not approximate the fuller therapeutic process.

Following this experimental line, Recher et al. conducted a double-blind RCT to evaluate whether targeted memory reactivation (TMR) during non-rapid eye movement sleep (NREM) enhances the effects of IR on aversive autobiographical memories [21]. After an IR session, 80 healthy adults with socially aversive but non- traumatic memories received individualized verbal cues associated with the updated memory during NREM sleep over two to five consecutive nights, while wearing a wearable EGG device. The control groups received either neutral cues or no cues.

Repeated assessments of emotional memory qualities, including valence, distress, arousal, and vividness, showed that IR alone produced robust improvements, consistent with prior work demonstrating its capacity to reduce negative affect and enhance adaptive interpretations. Notably, however, participants who received TMR during sleep exhibited additional gains beyond IR, particularly in reductions of distress, arousal, and vividness, and these effects appeared stronger with greater cueing exposure. These benefits persisted at both one-week and one-month follow-ups.

This study advances the investigation of IR's biological mechanisms by directly targeting the memory traces modified during IR. The durability of the effects suggests that sleep-dependent memory reactivation may reinforce the updating memory processes initiated through IR. consolidation processes influence the extent of emotional change.

Despite these strengths, interpretive constraints remain. The study relied on a non-clinical sample, limiting relevance to populations

for whom IR is typically used. The home-based EEG procedure, although ecologically valid, introduces uncontrolled variation in sleep quality and environment. Because the study did not include a comparison condition examining TMR after a non-imagery intervention, it is not clear whether TMR uniquely enhances IR or simply strengthens emotional associations of any kind.

Psychophysiological and neurophysiological correlates

Strohm et al. assessed whether IR enhances perceived mastery and reduces emotional reactivity to aversive memories at subjective and physiological levels [22]. They recruited 79 participants with distressing but non-traumatic memories who were randomly assigned to Imagery Rescripting, positive imagery, or a no-intervention control condition. Memory distress, helplessness, state stress symptoms, and perceived mastery were assessed alongside physiological indices such as heart rate, skin conductance, and facial electromyography during memory reactivation before the intervention and again after one week.

Compared with positive imagery and no-intervention control conditions, IR reduced subjective distress and helplessness more strongly. However, IR did not produce superior changes in physiological markers like heart rate, skin conductance, or facial electromyography relative to other conditions. In general, physiological responses decreased across all groups, and skin conductance increased over time, suggesting habituation rather than IR-specific effects.

The study contributes important findings showing that IR can successfully reduce subjective distress even when physiological signatures do not shift, highlighting potential dissociations between self-reported and autonomic responses. Nevertheless, non-clinical participants with less intense autobiographical distress may have exhibited limited physiological variability to begin with. Furthermore, habituation effects across all groups obscure any subtle physiological changes. These constraints suggest that although IR modifies subjective experience, its physiological correlation may require more sensitive paradigms or clinical populations to be detected.

In another study, Liu et al. explored immediate and lasting electrocortical effects of IR using Late Positive Potential (LPP) amplitudes, a well-established index of emotional reactivity, among young adults with childhood maltreatment histories [23]. The study included 61 young adults who completed two experimental phases. In the rescripting phase, they viewed neutral or unpleasant images and either visualized the unpleasant images as originally presented or modified them through rescripting, while subjective ratings of valence and vividness were collected. In the re-exposure phase, participants passively viewed the same images after a brief interval and reported the intensity of negative feelings, allowing the researchers to assess whether rescripting produced lasting changes in emotional responding.

During the rescripting phase, IR attenuated the late-LPP component and reduced subjective unpleasantness. During re-exposure, rescripted images elicited smaller LPP amplitudes and fewer negative feelings than images only visualized, indicating durable modulation of emotional processing beyond the immediate intervention window.

Individual differences were also examined. Notably, habitual imagery tendency moderated these effects, such that individuals who more frequently use mental imagery in daily life showed larger LPP reductions during both immediate and delayed assessments.

This study provides robust electrophysiological evidence that IR alters neural markers associated with emotional processing. The attenuation of late-LPP activity during rescripting and re-exposure offers an objective index of decreased emotional engagement, supporting theoretical claims that IR modifies reduces emotional distress. However, the artificial nature of the unpleasant images limits ecological validity because IR typically targets autobiographical content.

Emerging alternative interpersonal neurobiological mechanisms.

Recent efforts to clarify the mechanisms underlying Imagery Rescripting have begun to extend beyond cognitive and emotional processes to examine the interpersonal and physiological dynamics that unfold during treatment. One innovative study conducted by Prinz et al. examined therapist–client electrodermal synchrony during IR sessions for test anxiety, focusing specifically on whether synchrony was therapist-led or client-led and how these patterns related to clients' in- session emotional experiences [24]. The study included 50 client-therapist dyads who participated in a 6-session IR treatment, and electrodermal activity was recorded simultaneously from both partners during Sessions 3 and 4, which featured core rescripting procedures.

Cross-correlation analyses allowed the researchers to derive two synchrony indices per session: one capturing moments when clients' arousal shifts preceded and were mirrored by therapists, and the other when therapists' arousal shifts led and clients followed. Emotional states were assessed through brief Profile of Mood States ratings, and Actor-Partner Interdependence Models were applied to evaluate how synchrony and prior emotional states predicted clients' in-session affect.

They found that therapist-led synchrony was associated with greater contentment and trends toward increased vigor and calmness, as well as lower anxiety and depression among clients. Client-led synchrony, on the other hand, was associated with higher anxiety, suggesting possible dysregulation when clients' arousal shifts precede therapists'. This study contributes an innovative interpersonal perspective, suggesting that IR may involve biological coordination at the dyadic level. The association between therapist-led synchrony and more adaptive emotional experiences raises the possibility that interpersonal regulation may support clients' engagement in rescripting processes, and that additional interpersonal neurobiological mechanisms may be involved.

Nonetheless, the conclusions are limited by the use of a single physiological marker, electrodermal activity, which provides only partial insight into autonomic functioning. Important relational variables such as attachment orientation were not assessed, leaving unclear the extent to which synchrony reflects therapeutic technique versus attachment dynamics.

In a separate study, Toumbelekis et al. tested whether imagining an attachment figure immediately after fear conditioning reduces fear consolidation [25]. They included 75 undergraduate students who underwent a standard conditioning paradigm and were then randomly assigned either to imagine an attachment figure or to visualize an equally positive but non-attachment-related scenario. Fear-potentiated startle responses and shock-expectancy ratings were collected across conditioning and a next- day recall test, and individual differences in attachment security were assessed to explore potential moderators.

Participants who engaged in attachment imagery showed lower physiological and subjective fear recall twenty-four hours later than those who imagined a non- attachment-related positive scenario, suggesting that activating a secure attachment context can disrupt or weaken the consolidation of fear memories. This effect was strongest among more securely attached individuals and attenuated among those high in attachment anxiety, who tend to be preoccupied with abandonment and may have difficulty accessing the regulatory benefits of security cues. The authors situate these findings within neurobiological models of fear consolidation, proposing that attachment primes may influence amygdala-dependent protein synthesis and broader stress-related pathways, including glucocorticoid and noradrenergic activity regulated by the hypothalamic-pituitary-adrenal axis.

This study provides evidence that activating secure attachment representations modulates emotional memory consolidation, offering indirect relevance to IR because secure attachment figures are often incorporated into rescripting procedures. The findings suggest that attachment-related regulatory processes may weaken fear memory consolidation and thus may constitute a pathway through which IR exerts some of its emotional effects.

However, the study did not involve IR directly, and the use of conditioned fear stimuli limits generalizability to IR's focus on autobiographical memories. The authors recruited a non-clinical sample, constraining the translation of the findings to the clinical population. Crucially, no biological assays were collected despite the theoretical emphasis on neuroendocrine mechanisms, which restrict conclusions about underlying biological processes.

Conclusion

The studies reviewed provide emerging but still preliminary insight into the biological mechanisms that may underlie imagery rescripting (IR). Although none of the existing research directly measures IR-specific neural activity during aversive autobiographical memory modification, several patterns can be identified across studies that point toward plausible biological pathways engaged during the technique.

Across neuroimaging findings, reduced activation in the ventromedial prefrontal cortex (vmPFC) suggests involvement of brain regions associated with emotional meaning, regulation, and the reinterpretation of affective material. The vmPFC's role in appraisal and integration may reflect processes central to IR, such as altering the meaning of aversive autobiographical memories and reducing affective salience.

The studies examining sleep and memory provided some of the clearest indications that IR engages mechanisms consistent with memory updating. Both natural sleep and targeted memory reactivation (TMR) demonstrated the potential to modulate or strengthen emotional memory changes initiated during IR. The short-term benefits associated with sleep spindle density and the sustained improvements seen with TMR across multiple nights suggest that IR may rely on biological memory reconsolidation processes that are further supported when sleep-dependent consolidation mechanisms are engaged. These findings are consistent with IR's theoretical foundations, but remain preliminary, particularly because the samples were non-clinical and the IR protocols were abbreviated.

Psychophysiological studies yielded mixed results. Although IR consistently reduced subjective distress and helplessness, physiological markers such as heart rate, skin conductance, and facial electromyography did not reliably differentiate IR from comparison conditions. Additionally, habituation effects complicate interpretation across groups. In contrast, electrophysiological evidence from event-related potentials (ERPs) demonstrated that IR can produce immediate and lasting reductions in Late Positive Potential (LPP) amplitudes, suggesting measurable changes in neural responding to emotional stimuli. This electrophysiological evidence aligns with theoretical accounts of IR as a process that alters emotional engagement with aversive material.

Finally, research exploring interpersonal biological processes introduces an alternative mechanistic possibility. The finding that therapist-led synchrony is associated with more adaptive emotional experiences during IR suggests the involvement of interpersonal regulation processes that extend beyond the individual nervous system.

Complementary work on attachment imagery also indicates that activating secure attachment representations can weaken the consolidation of fear memories, which is relevant because IR often includes caregiver or protective figures as part of the rescripting process. Together, these studies highlight the potential contribution of relational and attachment-related biological mechanisms to the emotional changes produced in IR.

Altogether, the reviewed studies suggest that IR may involve multiple, interacting biological mechanisms such as the ventromedial prefrontal cortex (vmPFC), sleep- dependent re-consolidation pathways involving slow-wave sleep and sleep spindles; dynamic neural markers of emotional reactivity reflected in the late positive potential (LLP) amplitudes; autonomic responses during interpersonal interaction such as a electrodermal synchrony, and attachment-based modulation of stress and memory. At present, however, the evidence remains fragmented, methodologically heterogeneous, and largely indirect. Most studies use non-clinical samples, simplified IR protocols, or proxy tasks that approximate, but do not replicate, the core components of IR. As a result, current evidence provides promising directions but does not yet allow firm conclusions about IR's biological mechanism.

Future directions

Future research will require designs that directly measure

biological changes during full IR protocols, ideally using autobiographical stimuli and including neural, physiological, and relational indicators within the same study. Interestingly, one registered RCT study trial was found, which has not yet published results, and aims to investigate the neural and psychophysiological mechanisms of IR using fMRI, skin conductance, and self-report measures [26]. Such research is necessary to clarify whether IR's effects arise primarily from memory reconsolidation, emotional regulation, interpersonal regulation, or some combination of these processes. As interest in IR continues to grow, identifying its biological mechanisms will be critical for refining treatment protocols, understanding individual differences in responsiveness, and advancing theoretical models of how emotional memory can be transformed through imagery rescripting.

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