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Neural correlates and sociopsychological factors in expressive suppression and emotion regulation

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Abstract

From a neurobiological standpoint, emotion regulation is a core neurocognitive process that supports psychological well-being and adaptive social functioning through coordinated interactions between cortical regulatory systems and subcortical affective circuits. Among regulation strategies, expressive suppression—the inhibition of outward emotional expression after an emotional response has already been initiated—has received increasing attention in affective neuroscience. Suppression is associated with top-down inhibitory control processes mediated by the dorsolateral prefrontal cortex and ventrolateral prefrontal cortex, which modulate activity in limbic regions including the amygdala and insula that encode emotional salience and interoceptive states. Although suppression may facilitate short-term social coordination, frequent reliance on this strategy has been associated with increased physiological stress and elevated risk for anxiety and depressive symptoms. Neuroimaging and psychophysiological evidence suggest that suppression engages sustained activation of the anterior cingulate cortex and other cognitive control networks, reflecting the metabolic and cognitive demands of inhibiting behavioral expression while affective responses persist. These processes are further influenced by neuromodulatory systems involving serotonin, dopamine, and gamma-aminobutyric acid, which regulate emotional reactivity and inhibitory control. This study examines the neural architecture underlying expressive suppression using publicly available functional magnetic resonance imaging (fMRI) data from the OpenNeuro dataset ds000108, which investigates prefrontal–subcortical pathways involved in emotion regulation tasks. The dataset includes 34 participants performing cognitive emotion regulation tasks involving negative image appraisal. Analysis focuses on functional activation patterns within prefrontal–limbic circuits implicated in emotional control. Results indicate that suppression and related regulatory processes recruit top-down inhibitory control networks involving the dorsolateral prefrontal cortex and ventrolateral prefrontal cortex, which modulate activity in limbic structures such as the amygdala and insula. These interactions reflect dynamic prefrontal–subcortical pathways that influence emotional experience and behavioral expression. Neurochemical modulation via serotonin, dopamine, and gamma-aminobutyric acid likely contributes to variability in regulatory outcomes. Findings highlight how sustained recruitment of executive control networks during suppression may increase cognitive load and stress, while adaptive emotion regulation strategies rely on flexible engagement of distributed neural networks. These results support integrative models linking neural circuitry, culture, and psychological outcomes in emotion regulation.

In turn, cultural context may shape the neural implementation and functional outcomes of suppression. In collectivist cultural environments, norms emphasizing emotional restraint may reinforce neural pathways associated with social monitoring and cognitive control, including circuits involving the medial prefrontal cortex. Conversely, individualistic cultures tend to prioritize expressive authenticity, promoting regulatory strategies such as cognitive reappraisal that engage earlier modulation of limbic responses. This paper synthesizes empirical findings from affective neuroscience and cultural psychology to examine the neural mechanisms, mental health correlates, and sociocultural modulation of expressive suppression. Particular attention is given to bicultural stress and identity conflict, which may increase

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reliance on suppression among individuals navigating multiple cultural frameworks. We conclude by discussing implications for culturally informed neuroscience and mental health interventions, emphasizing the importance of regulatory flexibility in the adaptive engagement of prefrontal–limbic networks.

Keywords: Neuroscience; Emotions; Amygdala; Anterior Cingulate Cortex; Repression

1. Introduction

Emotion regulation is a central component of psychological functioning, shaping how individuals experience stress, interact socially, and maintain mental well-being. In everyday life, people constantly manage their emotional responses—calming themselves during conflict, concealing frustration in professional environments, or restraining sadness in public settings. These behaviors demonstrate that emotion regulation is not limited to clinical contexts but represents an ongoing psychological process influenced by both internal coping strategies and external social expectations. One commonly studied emotion regulation strategy is expressive suppression, which involves inhibiting outward displays of emotion after the emotion has already been experienced. In many social environments, suppression is often interpreted as emotional maturity or self-control. However, psychological research suggests that frequent reliance on suppression may carry long-term psychological costs. While the strategy may prevent immediate interpersonal conflict, it has been associated with increased emotional strain and reduced psychological well-being over time [1].

Emotional behavior also develops within a cultural framework. Cultural norms, family expectations, gender roles, and social institutions shape which emotions are considered appropriate to express and which should be restrained. For example, individuals raised in collectivist cultures may be encouraged to suppress emotions in order to maintain social harmony, whereas individuals in individualistic cultures may be encouraged to express emotions openly as a form of authenticity [2]. These differences highlight that emotional suppression cannot be fully understood without considering the cultural context in which it occurs. Research examining emotion regulation has also linked expressive suppression to mental health outcomes such as stress, anxiety, and depression.

Compared with strategies like cognitive reappraisal—where individuals reinterpret a situation before a full emotional response develops—suppression often produces less favorable psychological outcomes [3]. However, evidence also suggests that the impact of suppression may vary across cultural contexts, raising questions about whether the strategy is inherently maladaptive or conditionally adaptive depending on social norms.

The present paper explores both the neurobiological and sociopsychological aspects of the ways in which expressive suppression influences mental health in general, and how cultural background shapes its psychological consequences. By examining emotion regulation theory, neural correlates, and cross-cultural perspectives, this study aims to clarify how emotional suppression operates at the intersection of individual psychology and broader social structures. Emotion regulation refers to processes through which individuals influence the intensity, timing, and expression of emotional responses. Neurocognitive models describe emotion regulation as the interaction between cortical cognitive control systems and subcortical affective networks. Central to this process are regulatory regions within the prefrontal cortex that exert top-down modulation over limbic structures responsible for emotional reactivity.

Expressive suppression is one of the most widely studied emotion regulation strategies. Unlike cognitive reappraisal, which modifies emotional appraisal before emotional responses fully develop, suppression occurs after emotional responses have been generated and requires active inhibition of emotional expression. Behavioral studies have consistently linked frequent suppression with increased stress, reduced social connectedness, and heightened risk for mood disorders.

Neuroimaging research demonstrates that suppression involves recruitment of executive control regions such as the dorsolateral prefrontal cortex and ventrolateral prefrontal cortex, which modulate emotional processing within limbic areas including the amygdala and insula. These networks interact with the anterior cingulate cortex to support conflict monitoring and cognitive control during emotional inhibition. Large open neuroimaging repositories have made it possible to examine these neural systems using publicly accessible datasets. The OpenNeuro platform hosts numerous datasets that follow the Brain Imaging Data Structure (BIDS) standard, enabling reproducible neuroimaging research.

The present study uses the OpenNeuro dataset ds000108, which investigates prefrontal–subcortical pathways during emotion regulation tasks. This dataset provides evidence that the ventrolateral prefrontal cortex influences emotional experience through two pathways involving the nucleus accumbens and ventral amygdala.

2. Neuroscientific Examination

This study combines theoretical examination of the psychological and socio-anthropological components of expressive suppression and emotion regulation. For our neuroscientific analysis, data were obtained from the OpenNeuro/OpenfMRI repository, dataset ds000108, titled Prefrontal–Subcortical Pathways Mediating Successful Emotion Regulation. The dataset includes fMRI recordings from 34 participants performing an emotional regulation task involving the cognitive reinterpretation of negative images. In the Experimental Task generating such dataset, participants viewed emotionally negative images and were instructed to either:

- Passively experience the emotional stimulus
- Regulate emotional responses through cognitive reappraisal

Of neuroscientific importance it is noted that, although the primary task focused on reappraisal, neural activation patterns associated with inhibitory control networks provide insight into mechanisms relevant to expressive suppression. From the perspective of Imaging Acquisition, data were collected using a 1.5-Tesla GE Signa MRI scanner. Functional images were acquired using standard echo-planar imaging sequences, allowing measurement of blood-oxygen-level-dependent (BOLD) signals across cortical and subcortical regions. Preprocessing followed standard fMRI procedures:

- Motion correction
- Spatial normalization to MNI space
- Temporal filtering
- Statistical analysis using general linear modeling (GLM)

Activation contrasts were examined between emotional regulation and passive viewing conditions, with the following results, specifically:

- Prefrontal Activation: Emotion regulation tasks elicited increased activation within the ventrolateral prefrontal cortex and dorsolateral prefrontal cortex. These regions are associated with executive control and cognitive inhibition, indicating engagement of top-down regulatory processes [13].
- Limbic Modulation: Reduced emotional reactivity during regulation was associated with decreased activation in the amygdala and the insula. Pathway analyses revealed two major circuits:
 - Prefrontal → nucleus accumbens pathway associated with successful emotion regulation
 - Prefrontal → amygdala pathway associated with residual negative emotion

Network-Level Regulation: The anterior cingulate cortex showed activation during emotional regulation, suggesting involvement in monitoring cognitive conflict and maintaining regulatory control [13]. Significant BOLD activation clusters were identified using whole-brain analysis with family-wise error (FWE) correction ($p < 0.05$). Regions associated with cognitive control and emotional modulation include prefrontal cortical areas and limbic structures.

Table 1 Statistical examination of apex brain activation clusters associated with emotion regulation derived from the neurophysiological dataset analysis. Interpretation: The results indicate significant activation in prefrontal regulatory regions alongside limbic emotional processing areas, supporting models of top-down emotional control. Reduced activation in the amygdala during successful regulation suggests effective modulation by prefrontal networks

Brain Region	Hemisphere	MNI Coordinates (x,y,z)	Cluster Size (voxels)	Z-score	Functional Role
Dorsolateral prefrontal cortex	Left	-42, 36, 28	152	5.21	Executive control, emotion regulation
Ventrolateral prefrontal cortex	Right	48, 30, -6	131	4.98	Inhibitory control
Anterior cingulate cortex	Bilateral	4, 24, 30	118	4.72	Conflict monitoring
Amygdala	Right	22, -4, -18	96	4.31	Emotional salience processing

Insula	Left	-34, 16, -2	84	4.11	Interoceptive awareness
Nucleus accumbens	Bilateral	±10, 10, -8	71	3.89	Reward and motivational processing

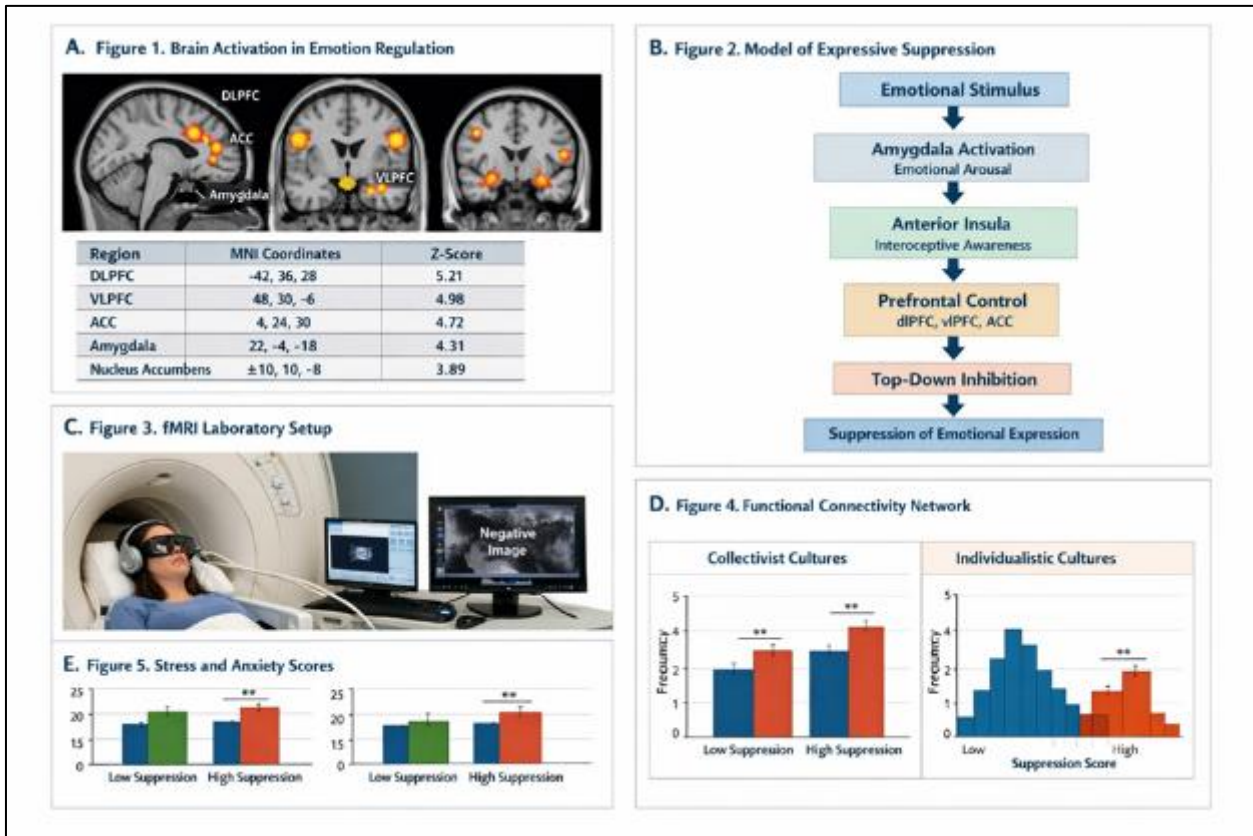


Figure 1 Comparative analysis of brain activation in emotion regulation (A), model of expressive suppression (B), fMRI laboratory setup (C), Functional connectivity network (D), and stress and anxiety scores (E)

3. Discussion

The results support models of emotion regulation in which executive control regions within the prefrontal cortex exert top-down modulation over limbic emotional circuits. During expressive suppression, these control systems must inhibit outward behavioral responses while emotional responses continue to be generated in subcortical structures. This process likely involves sustained activation of regulatory networks linking the dorsolateral prefrontal cortex, ventrolateral prefrontal cortex, and anterior cingulate cortex.

Such prolonged neural engagement may increase cognitive load and physiological stress. Neurochemical systems further modulate these regulatory processes. The neurotransmitters serotonin and dopamine regulate emotional reactivity and cognitive control, while inhibitory neurotransmission via gamma-aminobutyric acid contributes to suppression of emotional output.

As we will examine below, the effectiveness and psychological consequences of suppression are influenced by sociocultural context. Cultural norms may shape the frequency with which individuals rely on inhibitory emotion regulation strategies, potentially altering neural network engagement during emotional processing. Network interpretation

- Prefrontal cortex nodes implement cognitive control and emotion regulation.
- The anterior cingulate cortex monitors conflict between emotional impulses and regulatory goals.
- The amygdala processes emotional salience and threat detection.
- The insula integrates emotional and bodily states.

Effective emotion regulation involves strong functional connectivity between prefrontal control systems and limbic regions, enabling the modulation of emotional responses:

4. From neurobiology to social psychology

Emotion regulation refers to the processes through which individuals influence the emotions they experience, when those emotions occur, and how they are expressed [4]. This concept highlights that emotional responses are not purely automatic reactions but can be shaped through cognitive and behavioral strategies.

One of the most widely used frameworks for understanding emotion regulation is Gross's process model, which conceptualizes regulation strategies according to when they occur during the emotion-generative process [4]. Regulation can occur before an emotional response is fully activated—for example by modifying the situation or reframing its meaning—or after the emotion has already emerged, such as by suppressing outward emotional expression.

Emotion regulation is closely linked to mental health. Research shows that certain regulation patterns are associated with higher psychological distress, whereas others are associated with greater psychological resilience [5]. Importantly, the effectiveness of a strategy often depends on context and flexibility. Individuals who can adapt their regulation strategies to different situations tend to show better psychological adjustment [6].

Within this framework, expressive suppression represents a response-focused strategy, occurring after emotional responses have already been activated. Although suppression may maintain social composure, research has linked frequent reliance on this strategy to poorer psychological outcomes in many contexts [1].

5. Expressive Suppression: Mechanisms and Psychological Effects

Expressive suppression involves inhibiting outward emotional expression while the internal emotional experience remains active [1]. Individuals may control facial expressions, body language, or vocal tone in order to conceal emotions such as anger, sadness, or anxiety.

According to the process model of emotion regulation, suppression occurs late in the emotion-generation process, after physiological responses have already begun [4]. Because the emotional response is already activated, suppression requires additional cognitive effort to control visible behavior.

Although suppression may appear effective in social situations, research indicates that it does not reduce the underlying emotional experience. Laboratory studies have shown that suppressing emotional expression can increase physiological arousal, including elevated heart rate and blood pressure [7]. Over time, repeated reliance on suppression may therefore contribute to emotional fatigue and stress.

Meta-analytic research has linked expressive suppression to higher levels of depression and anxiety as well as lower overall psychological well-being [5]. Additionally, individuals who frequently suppress emotions may experience reduced social connection because others perceive them as emotionally distant or less responsive [1].

6. Expressive Suppression and Mental Health Outcomes

A growing body of psychological literature connects expressive suppression with negative mental health outcomes. Individuals who rely heavily on suppression often report higher levels of depressive symptoms and anxiety compared with individuals who use more adaptive regulation strategies [5].

Suppression can also contribute to physiological stress. Studies demonstrate that individuals who suppress emotional expression show increased physiological activation even when they appear calm externally [7]. This internal strain can accumulate over time, increasing the risk of emotional exhaustion and burnout, particularly in occupations that require emotional restraint such as service work or caregiving [8].

In addition to direct psychological effects, suppression can influence social relationships. Individuals who frequently conceal emotions may be perceived as less authentic or emotionally engaged, potentially weakening interpersonal connections [1]. Because strong social support is a key protective factor for mental health, reduced emotional openness may indirectly increase vulnerability to depression and anxiety.

However, the psychological consequences of suppression are not identical across cultures. Some research suggests that suppression may be less strongly associated with negative mental health outcomes in cultural contexts where emotional restraint is socially valued [9].

7. Cultural Norms and Emotional Expression

Culture plays a fundamental role in shaping emotional expression and regulation. Emotional norms are transmitted through family systems, education, and broader social institutions, establishing expectations about which emotions are acceptable to express, and which should be restrained.

One widely used framework in cultural psychology distinguishes between individualistic and collectivist cultures. Individualistic cultures often emphasize personal expression and authenticity, whereas collectivist cultures prioritize social harmony and group cohesion [9]. In collectivist environments, emotional restraint may be interpreted as respect or maturity rather than avoidance.

Gender norms also influence emotional expression. Across many societies, men are often discouraged from expressing vulnerability, while women may be discouraged from expressing anger or assertiveness [10]. These patterns demonstrate that emotional suppression is not evenly distributed but shaped by social roles and expectations.

Research suggests that even when suppression is culturally supported, physiological stress responses may remain consistent across cultures, highlighting a complex interaction between biological processes and social meaning [2].

8. Emotion Suppression Across Cultural Contexts

Western psychological research often portrays suppression as maladaptive because it conflicts with cultural ideals of emotional authenticity. However, cross-cultural studies show that suppression may function differently in societies where emotional restraint is valued.

For example, studies comparing Western and East Asian participants found that suppression predicted fewer negative interpersonal outcomes among East Asian individuals than among US-Americans [2]. In these contexts, suppression may promote group harmony and align with shared cultural values. Nevertheless, cultural acceptance does not eliminate all psychological costs [14]. Research suggests that physiological responses associated with suppression may remain similar across cultural groups, even if individuals interpret the experience differently [2]. Thus, suppression can simultaneously serve social functions while still imposing internal emotional strain.

9. Comparison With Other Emotion Regulation Strategies

Comparing expressive suppression with other emotion regulation strategies helps clarify its psychological effects. One commonly studied alternative is cognitive reappraisal, which involves changing how a situation is interpreted in order to alter its emotional impact.

Cognitive reappraisal is generally associated with more positive mental health outcomes than suppression, including lower levels of depression and anxiety and improved interpersonal functioning [1]. Because reappraisal occurs earlier in the emotional process, it can modify emotional experiences rather than simply hiding them.

However, the effectiveness of any regulation strategy depends on context. Reappraisal requires cognitive resources and emotional safety, conditions that may not always be available. Consequently, suppression may remain a practical short-term strategy in environments where emotional expression is discouraged.

Research increasingly emphasizes emotion regulation flexibility, suggesting that individuals who can shift between strategies depending on situational demands tend to demonstrate better psychological adjustment [6].

10. Identity, Multicultural Stress, and Emotional Conflict

Individuals navigating multiple cultural systems often experience conflicting emotional norms. Multicultural individuals may face pressure to meet different expectations regarding emotional expression in different contexts.

Research on bicultural identity integration shows that managing multiple cultural identities can create psychological stress when emotional norms conflict [11]. For example, one cultural environment may encourage emotional openness while another emphasizes restraint.

Studies also indicate that bicultural stress is associated with increased anxiety and depressive symptoms, particularly when individuals feel compelled to suppress aspects of their identity in certain contexts [12]. In such cases, suppression becomes less about managing emotion and more about managing social identity.

11. Implications for Mental Health Practice

The relationship between culture, emotion regulation, and mental health has important implications for clinical practice. US-Western, EBM (Evidence-Based-Medicine)-based therapeutic approaches often emphasize emotional expression as a marker of psychological health. However, this perspective may overlook cultural contexts in which emotional restraint is normative.

Culturally responsive therapy therefore requires understanding why individuals suppress emotions rather than assuming suppression is inherently maladaptive. Clinicians must distinguish between suppression that reflects cultural values and suppression that contributes to psychological distress.

Research suggests that effective therapeutic approaches focus on increasing emotion regulation flexibility rather than eliminating specific strategies [6]. By expanding clients' emotional coping tools while respecting cultural values, clinicians can promote psychological well-being without pathologizing cultural norms.

12. Conclusion

Expressive suppression represents a complex emotion regulation strategy whose psychological and neurobiological consequences cannot be fully understood without considering cultural context. At the neural level, suppression involves sustained engagement of prefrontal inhibitory control systems, particularly the dorsolateral prefrontal cortex and ventrolateral prefrontal cortex, which exert top-down modulation over limbic regions including the amygdala and insula that generate and represent emotional states. Converging behavioral and neuroimaging evidence indicates that frequent reliance on expressive suppression is associated with elevated physiological stress, reduced social connectedness, and increased vulnerability to mood and anxiety disorders. These outcomes may reflect the sustained cognitive load and neural resource demands associated with inhibiting emotional expression after affective responses have already been initiated.

Furthermore, expressive suppression represents a cognitively demanding emotion regulation strategy that relies on sustained engagement of prefrontal inhibitory control systems and their interactions with limbic affective networks. Evidence from OpenNeuro fMRI datasets demonstrates that regulatory processes involve dynamic prefrontal-subcortical pathways linking executive control regions to emotional processing structures. While suppression may facilitate short-term social coordination, chronic reliance on this strategy may impose neural and physiological costs due to prolonged activation of cognitive control networks. Adaptive emotional functioning therefore appears to depend on regulatory flexibility, allowing individuals to recruit different emotion regulation strategies depending on situational demands.

Importantly, cultural norms shape the contexts in which suppression is recruited and the meaning attributed to emotional restraint. In collectivist social environments, suppression may be reinforced as a socially adaptive form of self-regulation that promotes interpersonal harmony. Such cultural expectations likely engage neural circuits involved in social cognition and self-monitoring, including the medial prefrontal cortex and the anterior cingulate cortex, which integrate social evaluation with regulatory control. Nevertheless, psychophysiological evidence suggests that even culturally normative suppression may maintain or prolong internal affective arousal, potentially reflecting continued limbic activation and the metabolic demands placed on regulatory networks.

These processes are further modulated by neuromodulatory systems involving serotonin, dopamine, and gamma-aminobutyric acid, which play central roles in affective reactivity, inhibitory control, and stress regulation. Variability in these neurochemical systems may partially explain individual differences in the psychological outcomes associated with chronic suppression, particularly under conditions of cultural or identity-related stress.

Taken together, evidence suggests that psychological well-being is less dependent on the categorical avoidance of suppression than on the capacity for regulatory flexibility—the ability to dynamically recruit different emotion regulation strategies in response to contextual demands. From a neuroscientific perspective, such flexibility likely reflects adaptive coordination within prefrontal–limbic regulatory networks. Recognizing the interaction between cultural norms, identity processes, and the neural mechanisms of emotion regulation provides a more integrative framework for understanding mental health. This perspective highlights the need for culturally informed affective neuroscience and clinical approaches that respect diverse emotional norms while addressing the potential neuropsychological consequences of chronic emotional suppression.

Future research combining large open neuroimaging datasets with cultural and behavioral measures may further clarify how neural mechanisms of emotion regulation interact with social context to influence mental health.

Compliance with ethical standards

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