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Adult ADHD Comorbidity With Posttraumatic Stress Disorder and Acute Reaction to Stress

Supervisor Med. Dr. Indraja Veličkienė

Head of the department Prof. Med. Dr. Sigita Lesinskienė

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simon.legrum@mf.stud.vu.lt

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1. Abstract

Aim

This scoping review aims to explore and synthesize current understanding of the comorbidity between adult Attention-Deficit/Hyperactivity-Disorder and trauma-related disorders (posttraumatic stress disorder and acute stress reaction), with particular focus on their historical development, neurobiological underpinnings, and treatment strategies.

Methods

An extensive search was carried out across historical accounts, diagnostic-classification papers, neuroimaging and genetic studies, and contemporary treatment guidelines. Searches were performed in the major biomedical and psychological databases: MEDLINE/PubMed, Embase, APA PsycNET, Cochrane Library and Google Scholar.

Results

The review indicates that the comorbidity of adult Attention-Deficit/Hyperactivity-Disorder and Post-traumatic stress disorder not only shares clinical features such as inattention, restlessness, and emotional volatility but also converge on similar fronto-limbic circuitry disruptions, blurring diagnostic boundaries. These overlaps complicate therapy yet create opportunities for future integrated pharmacological and psychotherapeutic strategies that address both attentional and trauma-driven symptoms in tandem.

Conclusions

Overall, this review highlights current research and the need for future research into diagnostic trends and a more precise diagnostic framework, neurobiological and genetic studies, and combined treatment methods of adult Attention-Deficit/Hyperactivity-Disorder and Post-traumatic stress disorder.

Keywords

ADHD; PTSD; comorbidity; adult

2. Introduction

Although attention-deficit/hyperactivity disorder (ADHD) and post-traumatic stress disorder (PTSD) have each been studied extensively in isolation, their intersection and the clinical ramifications of their co-occurrence has only recently begun to receive systematic scrutiny; in this context, it felt important to understand how and why these conditions so often converge. Understanding the comorbidity between ADHD and PTSD has become a focus of research because these conditions frequently co-occur and can reciprocally exacerbate each other's impact [1].

Attention deficit hyperactivity disorder (ADHD) has been long recognized as a childhood-onset neurodevelopmental disorder. Early medical literature (e.g. George Still in 1902) described children with impulsive, inattentive behavior as having a "defect of moral control," laying the groundwork for a more scientific approach to the modern concept of ADHD. Originally thought to vanish in adolescence, ADHD is now known to persist in adulthood, affecting roughly 2.6% [2] of the global adult population, varying by region, gender and healthcare access. Crucially, adult ADHD rarely occurs in diagnostic isolation; multiple studies analyzed in a systematic review [3] show that most affected adults meet criteria for at least one additional psychiatric disorder, most often substance-use, mood or anxiety disorders, making ADHD a paradigmatic example of psychiatric multimorbidity.

The diagnosis of post-traumatic stress disorder (PTSD), on the other hand, emerged from historical war-time observation of trauma-related syndromes, from "soldiers' heart" in the American Civil War to "shell shock" in World War I, so called as it was initially thought to result from physical brain injury caused by artillery explosions. By 1980, PTSD was formally defined in the DSM-III as a psychiatric condition caused by traumatic events, incorporating symptoms like flashbacks, nightmares and feeling keyed up. This marked a shift from viewing trauma reactions as transient "war neuroses" to a lasting disorder with defined clinical criteria.

Epidemiological data indicates that adults with ADHD have a significantly elevated prevalence of PTSD compared to those without ADHD. An analysis of U.S. national survey data found that roughly 12% of adults with ADHD met criteria for PTSD in a given year, versus only about 3% of adults without ADHD [72]. Prominently, ADHD has been identified as a risk factor for developing PTSD after trauma. For example, combat veterans diagnosed with ADHD pre-deployment were over twice as likely to develop PTSD [112]. Additionally, individuals with PTSD often report lifelong attention problems suggestive of undiagnosed ADHD [109]. This overlap is significant: having both disorders is associated with more severe symptoms and poorer functional outcomes than either disorder alone. Patients with comorbid ADHD+PTSD tend to have higher rates of

psychiatric hospitalization, worse academic and occupational performance and an increased risk of additional comorbidities [103]. Therefore, understanding the link between ADHD and PTSD is critical for early identification and integrated treatment, possibly improving quality of life, treatment outcomes and is the purpose of this review.

3. Methods

The scoping literature review was conducted starting from August 2024, finishing in May 2025. Research and article selection was carried out continuously during this period, due to the integrated studies system of the student (medical internship rotations). Search was performed in the major databases: MEDLINE/PubMed, Embase, APA PsycNET, Cochrane Library, and Google Scholar. Key search words included: ADHD; PTSD; comorbidity; adult. As the topic of comorbid ADHD an PTSD is relatively new, most articles pertaining to it were published in the last 15 years. In order to achieve a scoping overview of the current research landscape, selected studies were emphasized to be systematic reviews and meta-analyses. Case studies and pilot studies were used to illustrate possible advances. Other articles, though these might be older, were chosen to create a scientific base to show the progress of research in ADHD and PTSD.

4. Literature review

4.1 Historical Background

ADHD

References to ADHD-like symptoms date back over two centuries. In 1775, Melchior Adam Weikard described a condition of attention deficit (“Mangel der Aufmerksamkeit”) in his textbook [4], and around 1798, Sir Alexander Crichton wrote about a “disease of attention,” noting an inability to sustain focus [5]. These observations suggest that problems with inattention and self-regulation were recognized well before the 20th century, though they were not conceptualized as a distinct childhood psychiatric disorder.

A major milestone emerged in 1902, when British pediatrician Sir George Frederic Still presented a series of lectures describing 43 children with serious problems in sustained attention, impulse control and hyperactivity; children who were defiant, overly emotional and unable to learn from consequences despite normal intelligence [6]. He referred to their condition as an “abnormal defect of moral control” and posited an underlying biological predisposition rather than mere poor

upbringing [6]. Although overshadowed at the time, Still's lectures are now regarded as the first scientific description of what we call ADHD.

In the subsequent decades, some clinicians linked hyperactive behavior to possible brain injury or dysfunction; for instance, the influenza/encephalitis epidemic of 1917-1918 left children with impulsive, overactive behavior, then termed "post-encephalitic behavior disorder" [7][8]. By the 1940s, concepts like "minimal brain damage" or "minimal brain dysfunction" arose to account for hyperactivity and attention difficulties despite no obvious neurological lesion [9][10]. This label shifted to "hyperkinetic impulse disorder" by the late 1950s [11]. Although ideas about etiology changed, the focus remained on children with severe hyperactivity and impulsivity. The condition was generally deemed to remit by adolescence, ignoring the attentional issues that could persist. Only in the 1970s did research highlight attention deficits as core features and recognize the possibility that ADHD might continue into adulthood [10][12].

Management of ADHD progressed alongside evolving theories of its etiology. Early 20th-century interventions were largely educational or behavioral: structured routines, disciplinary methods and special classrooms [10]. The pivotal discovery in 1937 by Dr. Charles Bradley revealed that stimulant medication (Benzedrine) had a paradoxical calming effect on children with hyperactivity, improving attention and reducing disruptive behavior [13]. Initially overlooked, stimulants such as methylphenidate (Ritalin) and amphetamines gained acceptance in the 1960s, backed by empirical evidence that they significantly improve core ADHD symptoms [14].

By the 1970s, medication use for "hyperkinetic" children expanded, sometimes leading to public backlash over concerns of over-prescription [15]. Nonetheless, professional bodies like the American Academy of Pediatrics supported the legitimacy of stimulant therapy, along with behavioral interventions [16]. Behavior therapy and educational accommodation became integral, forming what is now known as multimodal treatment [17]. The 1999 NIH-funded Multimodal Treatment of ADHD (MTA) study demonstrated that medication (alone or with behavioral therapy) was superior to behavioral therapy alone for core symptom reduction, though combined therapy added social/functional benefits in some cases [18].

In the 2000s, non-stimulant medications (e.g., atomoxetine) provided alternatives for those intolerant or unresponsive to stimulants [19].

Today, ADHD is conceptualized as a complex neurodevelopmental disorder with strong genetic heritability (about 70–80%) [20]. Neuroimaging studies demonstrate differences in brain networks governing attention and impulse control, particularly in the prefrontal cortex and basal ganglia, along with a developmental lag in cortical maturation for some patients [21][22]. The disorder's

heterogeneity is reflected in the DSM-5 presentations (inattentive, hyperactive-impulsive, or combined) [23], and in the varied trajectories, some individuals show reduced hyperactivity by adolescence, but inattentiveness often lingers into adulthood [24].

Current management emphasizes individualized, multimodal treatment [25]. Medication, stimulant or non-stimulant, remains first-line for core symptoms, supplemented by behavioral therapies and accommodation at school or work [26]. Growing awareness of adult ADHD spurs new screening protocols, such as identifying financial or relationship problems [27][28], and therapies geared to adult challenges. There is also ongoing debate about overdiagnosis in some regions (due to heightened awareness or pressure for performance) versus underdiagnosis in others (due to limited resources or stigma, especially for females or minority populations) which will be explored further in the section on diagnosis. Future directions include precision medicine approaches, exploring whether genetic or neuroimaging markers might predict treatment response. Digital therapeutics, neurofeedback, and computer-based cognitive training are also being investigated for adjunctive benefit. The ultimate goal is to move beyond symptom control and facilitate overall functioning, with earlier interventions leading to better lifelong outcomes.

PTSD

Well before PTSD became an official diagnosis, doctors and laypeople observed psychological trauma reactions, particularly in wartime. In the American Civil War, terms like “nostalgia” described soldiers too emotionally broken to continue fighting, while “soldier’s heart/Da Costa’s syndrome” [29] referred to rapid pulse, chest pain, and anxiety, now regarded as stress-induced symptoms. In the late 19th century, “railway spine” was observed in survivors of train accidents, attributed to microscopic lesions from collisions but with an emerging awareness of psychological factors [30].

During World War I, the concept of “shell shock” gained prominence. First documented by British physician Charles S. Myers in 1915, shell shock involved tremors, nightmares, anxiety and sensory disturbances in soldiers exposed to exploding artillery shells [31]. Initially viewed as physical concussive damage, doctors realized the same symptoms appeared in soldiers with no blast exposure, revealing psychological elements [31]. By the war’s end, 80,000 cases of shell shock were documented in the British Army alone, yet treatments were primitive, ranging from brief rest to electroshock or hypnosis [32].

In World War II, “battle fatigue” or “combat exhaustion” replaced shell shock, recognizing that prolonged combat tours led to psychological collapse. Proximity, Immediacy, Expectancy (the PIE model) guided quick treatment near the front to reduce stigma and chronic disability [33]. Despite

these improvements, many veterans developed long-lasting symptoms. High-profile military leaders sometimes dismissed combat stress as cowardice, underscoring the stigma faced by these individuals [34]. Beyond soldiers, attention turned to civilians traumatized by bombings, concentration camps [35] or disasters but a unified concept of post-traumatic stress outside of combat was still evolving. By the Vietnam War era, recognition grew that many veterans suffered "post-Vietnam syndrome" with chronic psychological disturbances, broadening the scope to civilians as well [36].

After PTSD's inclusion in DSM-III (1980), psychological interventions expanded. Two cornerstone cognitive-behavioral therapies (CBTs) emerged: Prolonged Exposure (PE) [37], developed by Edna Foa, and Cognitive Processing Therapy (CPT) [38], developed by Patricia Resick . Prolonged Exposure uses repeated recounting or re-living of trauma memories to diminish their power, while CPT targets distorted trauma-related beliefs (e.g., self-blame) to reshape the patient's understanding. Both achieved strong empirical support. Eye Movement Desensitization and Reprocessing (EMDR), introduced by Francine Shapiro in 1989, combined exposure with bilateral eye movements, gaining recognition as another evidence-based method [39].

Pharmacotherapy progressed too. Early approaches used sedatives or tranquilizers symptomatically, but Selective Serotonin Reuptake Inhibitors (SSRIs) later proved effective for a range of PTSD symptoms. Sertraline [40] and paroxetine became the first FDA-approved medications for PTSD in the late 1990s. They remain front-line pharmacologic options [41], when combined with psychotherapy. Off-label medication strategies include prazosin for nightmares [42], SNRIs or atypical antipsychotics in complex cases [41].

The contemporary view of PTSD is that it arises from an interplay of psychological, biological, and social factors following exposure to trauma [43]. While not everyone who experiences trauma develops PTSD, risk factors include the severity/duration of trauma, pre-existing vulnerabilities, and limited social support [44]. Neurobiologically, PTSD involves hyperactivation of the amygdala (fear center), reduced regulatory function in the medial prefrontal cortex, and smaller hippocampal volume, disrupting normal fear extinction processes [45]. There is moderate genetic influence, with twin studies suggesting a heritability of about 30–40% [46], and epigenetic research indicates that trauma can alter gene expression, potentially compounding vulnerability [47][48].

Clinically, trauma-focused psychotherapies (Prolonged Exposure, Cognitive Processing Therapy, EMDR) remain first-line treatments, often combined with SSRIs or SNRIs if needed [41]. However, a significant subset of patients remains symptomatic, fueling research into new treatments like transcranial magnetic stimulation [49], stellate ganglion block [50], ketamine [51], and MDMA-

assisted therapy. The latter showing promising Phase 3 trial results, with up to two-thirds of chronic PTSD patients responding positively [52].

Finally, trauma-informed care, in education, healthcare, and public institutions, seeks to identify and support at-risk individuals before PTSD becomes entrenched [53]. Future research will likely refine our understanding of PTSD's neurobiology, genetics, and treatment matching, with an emphasis on integrated care for comorbid issues (e.g., ADHD, depression, substance use) and social support systems to foster resilience. The field is moving toward a comprehensive view that addresses both symptom remission and functional recovery, helping individuals not only survive trauma but also potentially experience post-traumatic growth.

4.2 Diagnostic Criteria in DSM-5-TR vs. ICD-11

ADHD Diagnostic Criteria

The DSM-5-TR and ICD-11 criteria for ADHD show substantial overlap but also important differences in symptom definitions and organization. DSM-5-TR lists 18 core symptoms (9 symptoms of inattention and 9 of hyperactivity/impulsivity) [54]. In contrast, ICD-11 defines 11 symptoms in each domain, inattentiveness and hyperactivity/impulsivity, although one symptom ("fidgeting" in children) is considered age-specific, effectively making 10 hyperactivity/impulsivity items for adolescents/adults [54]. Thus, ICD-11 includes a couple of additional symptom descriptions not explicitly separate in DSM-5-TR. Despite these differences in number, many symptoms overlap in meaning.

A notable difference is in how each system sets thresholds for diagnosis. DSM-5-TR requires a clear minimum number of symptoms per category: at least 6 symptoms of inattention and/or hyperactivity-impulsivity for children (age <17), or at least 5 if diagnosing in adolescents/adults (age ≥17) [54]. These symptoms must be present often and to a maladaptive degree, as per DSM criteria. ICD-11, by comparison, describes ADHD in more qualitative terms without a strict symptom count for diagnosis. It defines presentations where inattentive symptoms predominate, hyperactive/impulsive symptoms predominate, or both symptom sets are present "with neither predominating" (combined type) [56]. However, ICD-11's text does not explicitly require a specific minimum count of symptoms from each domain, instead emphasizing that multiple inattentive and/or hyperactive-impulsive symptoms should be evident to a degree that is inconsistent with developmental level and causes impairment. DSM-5-TR's explicit numerical threshold provides clarity and standardization, whereas ICD-11's approach allows clinical judgment in determining if symptoms are sufficient possibly affecting specificity and consistency. One commentary notes that DSM-5-TR's clearly defined symptom counts vs. ICD-11's lack of standardized count is a key

difference with implications for reliability of diagnosis [54]. In practical terms, clinicians using DSM checklists have a firm cutoff, while ICD-11 relies more on overall clinical impression of symptom pervasiveness.

Both DSM-5-TR and ICD-11 require that ADHD symptoms begin in childhood, aligning on the criterion that several symptoms should be present by age 12 (DSM-5-TR raised this from age 7 in earlier editions). ICD-11 similarly uses 12 years old as the typical latest age of onset for symptom emergence, reflecting the same evidence. Both systems also require that the symptoms be present in multiple settings (e.g. school, work, home) and cause significant impairment in functioning. These similarities mean that both DSM-5-TR and ICD-11 are targeting a consistent clinical picture of early-onset, pervasive attentional and impulse-control difficulties.

DSM-5-TR specifies three presentations: predominantly Inattentive (ADHD-I), predominantly Hyperactive/Impulsive (ADHD-H), or combined (ADHD-C), based on meeting the threshold in one or both symptom domains. ICD-11 also recognizes that ADHD can present with mainly inattentive features, mainly hyperactive-impulsive features, or a combined pattern. However, ICD-11's descriptions are less rigid but coded differently. For example, combined presentation in ICD-11 is described as both inattentive and hyperactive-impulsive symptoms being present "with neither predominating," rather than requiring at least 6 of each as in DSM-5-TR. In practice, this means DSM-5-TR has more strictly defined subcategories, whereas ICD-11 relies on clinical judgment to determine if one domain "predominates." The alignment between the two systems improved compared to prior editions (ICD-10 had only a narrower "Hyperkinetic Disorder" which roughly corresponded to severe combined-type ADHD) [54]. ICD-11's inclusion of milder presentations (not just the full hyperkinetic syndrome) marks a convergence with DSM, improving the effectiveness of identifying ADHD across a broader spectrum.

DSM-5-TR's criteria, with their structured symptom list and thresholds, provide high sensitivity to typical ADHD cases and ensure a level of consistency in diagnosis across practitioners Lowering the symptom count threshold for adults (from 6 to 5) also increased sensitivity to persistent but perhaps subtler adult symptoms. These changes mean more adults who legitimately have ADHD can be recognized, but they also open the door to potential false positives if normal-range inattentiveness in adulthood is mistaken for pathology. ICD-11's criteria arguably strive for specificity by not simply counting symptoms, instead focusing on clear impairment and developmental deviation. The ICD-11 approach may avoid pathologizing individuals who have numerous mild symptoms that don't truly impair them. Still, the trade-off is that the absence of a numeric threshold which could lead to variability, one clinician might diagnose with 4-5 symptoms if they judge impairment is high, while another might require more. This could impact reliability

between clinicians and studies. One analysis highlighted that the lack of a standardized symptom count in ICD-11 is an obstacle for validity and reliability, potentially affecting diagnostic specificity (risk of under- or over-identifying ADHD depending on clinician interpretation) [57].

A practical issue in applying criteria is the use of rating scales and checklists. DSM-based ADHD rating scales (such as the Conners Rating Scales, ADHD Rating Scale-5, or Adult ADHD Self-Report Scale) are widely used to quantify symptom frequency. These scales correspond directly to DSM symptom lists and thresholds. By contrast, ICD-11 currently has no official or widely validated ADHD-specific rating scales aligned to its slightly different symptom set. This absence has a real impact: clinicians and researchers often continue using DSM-5-oriented measures even in settings where ICD-11 is the official system, because no alternative exists yet. Using DSM-based scales for an ICD-11 diagnosis can be workable but might not capture the few unique ICD-11 symptoms and could misjudge threshold since DSM scales assume the DSM cutoffs. Researchers Gomez et al. (2022) note that *"*no ICD-11 based ADHD rating scales exist and while this absence represents an obstacle for research and clinical practice, it also presents opportunities for research development*"* [54]. In other words, the field is challenged to develop new assessment tools that match ICD-11's formulation of ADHD. For now, the lack of ICD-specific scales may impact clinical practice by causing clinicians to rely on DSM definitions (potentially leading to the same diagnosis one way or the other, but reducing the distinctive application of ICD-11). It may also affect epidemiological estimates, studies might still be using DSM criteria, meaning we have less data on ADHD prevalence strictly according to ICD-11. Overall, both DSM-5-TR and ICD-11 are effective in identifying ADHD, but these nuanced differences (symptom count, threshold clarity, and available assessment tools) can influence diagnostic outcomes and the ease of application in practice.

Table 1: Comparison of ADHD between DSM-V and ICD-11 diagnostic criteria

Diagnostic System	**DSM-5**	**ICD-11**
Core symptom domains	Two separate domains: - Inattention (9 criteria) - Hyperactivity-Impulsivity (9 criteria)	Two domains: - Inattention manifestations (11) - Hyperactivity-Impulsivity manifestations (11)
Number of symptom criteria	12 total (6 Inattention + 6 Hyperactivity-Impulsivity)	No enumerated count; diagnosis based on clinically significant pattern

Table 1: Comparison of ADHD between DSM-V and ICD-11 diagnostic criteria “continued"

Examples of symptoms	Inattention: • Fails to give close attention / careless mistakes • Difficulty sustaining attention • Often seems not to listen • Does not follow through / loses focus • Difficulty organizing tasks • Avoids tasks needing sustained effort • Often loses items • Easily distracted • Forgetful in daily activities	Inattention examples: • Difficulties sustaining attention to low-stimulation tasks • Distractibility • Disorganization / forgetfulness
	Hyperactivity-Impulsivity: • Fidgets or squirms • Leaves seat • Runs/climbs excessively • Difficulty playing quietly • "On the go" / acts as if driven by a motor • Talks excessively • Blurts out answers • Difficulty waiting turn • Interrupts or intrudes	Hyperactivity-Impulsivity examples: • Excessive motor activity / fidgeting • Difficulty remaining still, especially in structured situations • Talkativeness / impulsive actions • Acting without consideration of consequences
Symptom threshold	Children < 17: ≥ 6 in one domain; ≥ 17 yrs: ≥ 5	No numeric threshold; clinician judges clinically significant, developmentally inappropriate pattern
Duration	Persist ≥ 6 months.	Persist ≥ 6 months.
Age of onset	Several symptoms before age 12	Evidence of symptoms before age 12
Settings required	Symptoms present in ≥ 2 settings	Manifestations evident across multiple settings.
Functional impact	Clinically significant impairment in social, academic or occupational functioning.	Direct negative impact on academic, occupational or social functioning.
Presentations & codes	Pred. Inattentive F90.0 Pred. Hyperactive-Impulsive F90.1 Combined F90.2	Pred. Inattentive 6A05.0 Hyperactive-Impulsive 6A05.1 Combined 6A05.2
Specifiers & severity	Partial remission; Mild / Moderate / Severe	Severity extension: Mild / Moderate / Severe
Exclusion criteria	Not better explained by other disorders.	Not solely attributable to developmental level or other disorder.

*Sources [56][55]

PTSD Diagnostic Criteria (DSM-5-TR vs. ICD-11)

The DSM-5-TR and ICD-11 criteria for PTSD differ more dramatically in scope than those for ADHD. DSM-5 (and DSM-5-TR) defines PTSD broadly, with eight criteria (A-H). To establish a DSM-5 PTSD diagnosis, an individual must have: at least 1 intrusion symptom (out of 5 possibilities, e.g. intrusive memories, nightmares, flashbacks); at least 1 avoidance symptom (out of 2, avoiding reminders/related emotions of the trauma); at least 2 symptoms of negative alterations in cognitions and mood (out of 7, e.g. persistent negative beliefs, blame, estrangement, inability to experience positive emotions); and at least 2 arousal and reactivity symptoms (out of 6, such as hypervigilance, exaggerated startle, irritability, sleep disturbance) . These, along with the required trauma exposure (Criterion A) and duration and impairment criteria, compose the DSM-5 PTSD diagnosis. In total, DSM-5's PTSD construct has four symptom clusters (B-E) and a fairly extensive set of symptoms, capturing a wide range of post-traumatic manifestations [58].

In contrast, ICD-11 takes a much more focused approach, featuring only 3 symptom clusters and a total of 6 core symptoms [59]. ICD-11 requires the presence of: at least 1 intrusive re-experiencing symptom (of 2 defined, e.g. distressing involuntary recollections or dreams); at least 1 avoidance symptom (of 2, avoiding thoughts or situations reminiscent of the trauma); and at least 1 symptom of persistent sense of threat (of 2, which include hypervigilance or an enhanced startle reaction) [59]. These roughly correspond to intrusion, avoidance, and hyperarousal categories, respectively. Notably, ICD-11 omits the broad DSM category of negative mood and cognition alterations as separate criteria. Symptoms like persistent negative emotions, distorted blame of self/others, or pervasive feelings of detachment are not required or listed in ICD-11's PTSD, these are considered non-specific symptoms that often overlap with depression or other disorders. By eliminating non-specific symptoms, ICD-11 defines PTSD in a narrower fashion, aiming to identify the core elements of a traumatic stress response. The underlying rationale is to improve diagnostic precision: a smaller, more distinct set of symptoms hopes to reduce overlap with anxiety, depression, or personality changes that could come from trauma but are not unique to PTSD.

Table 2: Comparison of PTSD between DSM-V and ICD-11 diagnostic criteria

Diagnostic System	DSM-5	ICD-11
Core symptom clusters	4 clusters: - Intrusion (5) - Avoidance (2) - Negative alterations in cognition & mood (7) - Alterations in arousal & reactivity (6)	3 clusters: - Re-experiencing in the present - Avoidance of reminders - Sense of current threat (hyper-arousal)

Table 2: Comparison of PTSD between DSM-V and ICD-11 diagnostic criteria "continued"

Total number of distinct symptoms	20 (5 + 2 + 7 + 6)	6 typical symptoms (2 manifestations per cluster)
Symptom threshold	≥ 1 Intrusion ≥ 1 Avoidance ≥ 2 Negative mood/cognition ≥ 2 Arousal/reactivity	At least 1 symptom from each cluster
Illustrative symptoms	Intrusion: intrusive memories, nightmares, flashbacks, intense distress, physiological reactivity. Avoidance: avoids memories/feelings; avoids external reminders. Neg. cog./mood: amnesia, negative beliefs, blame, persistent negative emotions, diminished interest, detachment, anhedonia. Arousal: irritability/anger, reckless/self-destructive behaviour, hypervigilance, exaggerated startle, poor concentration, sleep disturbance.	Re-experiencing: vivid intrusive memories/flashbacks, nightmares. Avoidance: avoids thoughts/feelings, avoids external cues. Sense of threat: hypervigilance, exaggerated startle response.
Exposure criterion	Must be exposed to actual/threatened death, serious injury, or sexual violence (Criterion A)	Exposure to an extremely threatening or horrific event or series of events
Duration	Symptoms > 1 month after trauma	Symptoms persist for several weeks and cause impairment (typically ≥ 1 month)
Functional impairment	Clinically significant distress or impairment in social, occupational, or other areas	Significant impairment in personal, family, social, educational, occupational, or other areas
Specifiers / subtypes	With dissociative symptoms, With delayed expression (> 6 mos post-event); Preschool subtype (< 6 yrs)	No specifiers: Complex PTSD (6B41) is coded separately

*Sources [59][58]

One fundamental difference stemming from the above is the handling of complex trauma reactions. DSM-5-TR's single PTSD category is meant to cover the full range of PTSD presentations, including those with complex features but DSM-5 does allow specifiers like "with dissociative symptoms". The DSM broadened PTSD in part to acknowledge symptoms like emotional dysregulation and negative self-beliefs within PTSD's umbrella [60]. In contrast, ICD-11 introduces a separate diagnosis of Complex PTSD (CPTSD) for cases involving not only the core PTSD symptoms but also chronic and pervasive disturbances in self-organization. These typically manifest as problems with emotional regulation, negative self-concept, and difficulties in relationships, often

seen after prolonged or multiple traumas (e.g. childhood abuse, torture) [61]. ICD-11's creators essentially split PTSD into two conditions: PTSD (a more focused fear-based response) and Complex PTSD (which includes PTSD plus these additional severe symptoms). This difference shows an opposite philosophy: ICD-11 makes a categorical distinction for complex cases, whereas DSM-5 expanded the PTSD criteria to encompass them within one diagnosis. Each approach has implications. ICD-11's narrower PTSD definition increases specificity, patients with primarily mood or interpersonal issues post-trauma might not qualify for PTSD unless they also have the core fear-based symptoms, potentially avoiding overdiagnosis. And those who do have the broader disturbances get labeled as CPTSD, highlighting the need for more intensive treatment. However, critics note this could be seen as a severity continuum [62] rather than a truly separate category, and worry that separating CPTSD might lead clinicians to assume "simple PTSD" (without those features) is easier to treat than it often is. DSM-5's approach [63], on the other hand, ensures no one with serious post-traumatic symptoms is left out of diagnosis (they will all fall under PTSD), but by doing so, the PTSD label covers a very heterogeneous group: from relatively circumscribed fear responses to very complex syndromes, which can complicate treatment planning and research. In summary, ICD-11 carved out Complex PTSD as distinct, whereas DSM-5 folded it into PTSD by broadening criteria.

The impact of these differences is seen in prevalence and diagnostic specificity. DSM-5's broad criteria can yield higher rates of PTSD diagnosis because it counts symptoms that are common but not unique to trauma, e.g. self-blame or negative emotions, potentially capturing individuals who have significant distress after trauma but who might not have been included under narrower definitions. ICD-11's PTSD, being more narrowly defined, is expected to identify fewer individuals, ideally only those with hallmark trauma-recovery problems, thereby reducing false positives. Research comparing the two definitions tends to show DSM-5 identifying more cases than ICD-11. For example, one study found that the ICD-11 criteria produce lower PTSD prevalence than DSM-5 in the same populations [64]. In one review of adult trauma survivors, ICD-11 PTSD prevalence was significantly lower than DSM-based PTSD, meaning some people who meet DSM criteria do not meet ICD-11 criteria [65]. One study of trauma-exposed adolescents in China reported no significant difference in prevalence between DSM-5 and ICD-11 definitions [66] but generally in adults DSM-5 tends to cast a wider net. Hypothetically, an adult sample might have more patients meeting DSM-5 PTSD vs meeting ICD-11 PTSD criteria, with those extra DSM cases likely to have symptoms such as negative mood or numbing without strong hypervigilance, which ICD-11 does not count as PTSD. This suggests DSM-5 criteria may be more sensitive to varied trauma responses, whereas ICD-11 is more specific, possibly at the cost of missing some impaired

individuals who don't fit its trimmed definition. The U.S. National Center for PTSD noted that ICD-11's definition can detect some individuals with impairment who wouldn't get DSM-5 PTSD but also vice versa, DSM may capture others that ICD misses, reflecting the trade-offs in broad vs. narrow criteria [67].

Just as with ADHD, the availability of diagnostic instruments matters. The DSM-5 has the PCL-5 (PTSD Checklist) and the clinician-administered CAPS-5, among others, which map onto DSM criteria. When ICD-11 introduced its new PTSD definition, new instruments were developed, notably the International Trauma Questionnaire (ITQ), to specifically measure ICD-11 PTSD and Complex PTSD symptomatology. The absence of ICD-11 PTSD scales in the immediate aftermath of its release meant many clinicians and researchers continued using DSM-based assessments, possibly under-diagnosing ICD-11 PTSD or having to approximate it. Now, the ITQ is available and gaining use, but it's not yet as widespread as DSM-based tools. In routine practice, especially in countries or settings that adopt ICD-11, clinicians must be mindful: if they use DSM-oriented checklists, they might end up giving a DSM diagnosis even if officially they are supposed to use ICD criteria. Conversely, strictly applying ICD-11 criteria without tools requires careful clinical interviewing to ensure the presence of each of the 3 symptom clusters. In summary, differences in PTSD criteria between DSM-5-TR and ICD-11 have a direct impact on diagnosis, potentially leading to different diagnoses for the same patient depending on which system is used

One recurring theme in comparing DSM-5-TR and ICD-11 is the lack of integrated assessment tools in the ICD-11 framework, particularly for ADHD (and initially for PTSD) [54]. Unlike DSM, the ICD is primarily a classification system and does not provide companion symptom checklists or questionnaires; it assumes clinicians will apply the narrative criteria [68]. In ADHD this gap is especially big. As of the current revision, no official ICD-11 ADHD rating scale exists. Clinicians therefore often use DSM-based rating scales, such as the ADHD Rating Scale or Conners forms for parents/teachers which align with DSM symptom counts, when evaluating patients, even if they intend to diagnose via ICD-11. This practice can cause subtle mismatches, for example, an ICD-11 diagnosis might consider a symptom that the DSM scale didn't ask about, or a DSM-based cutoff might not directly translate to ICD's requirements. Researchers caution that existing DSM-based ADHD scales "may not be appropriate for ICD-11 defined ADHD assessment" and emphasize the need to develop new measures based on ICD-11 criteria [54]. The impact on clinical practice is that many clinicians effectively continue to think in DSM terms due to the tools at hand, potentially undermining the intended differences of ICD-11. Until ICD-specific scales are created and adopted, diagnoses under ICD-11 may not fully capitalize on its revised criteria, and cross-national research could be hampered by lack of comparable instruments.

For PTSD, the issue was addressed more quickly: the International Trauma Questionnaire (ITQ) was developed by experts alongside ICD-11 to fill the measurement gap [69]. Still, the vast majority of PTSD research and clinical screening has used DSM-based tools, like the PCL. This means initial studies comparing DSM-5 and ICD-11 PTSD often had to retrofit DSM assessments to approximate ICD-11 criteria or administer lengthy interviews to check ICD-11's fewer symptoms. In practice, a clinician using ICD-11 should ideally use the ITQ or a similar measure to avoid over- or under-diagnosing PTSD relative to the intended criteria. The absence of rating scales in ICD-11 thus primarily affects consistency and ease of diagnosis. Clinicians must rely more on their judgment and structured interviews. Over time, as new scales are validated, this impact will lessen, but it highlights a transitional challenge in moving from DSM-guided practice to ICD-11-guided practice.

In summary, the DSM's inclusion of detailed criteria and the myriad of DSM-based questionnaires have long supported clinicians in making diagnoses. ICD-11's differences mean practitioners must adapt or wait for similar tools. This can affect training, professionals need to learn ICD-11 nuances rather than just using DSM checklists, and potentially the recognition of disorders. For example, a mild case of PTSD might score below threshold on the PCL-5 but still meet ICD-11 criteria (since ICD-11 requires fewer symptoms, but specific ones) or vice versa. Without appropriate scales, such a case could be misclassified.

4.3 Overdiagnosis and Underdiagnosis Trends of ADHD

ADHD diagnosis rates have risen substantially in recent decades, especially in children. For instance, U.S. national survey data showed parent-reported ADHD diagnoses increasing from about 6.1% of children in 1997 to 10.2% by 2016 [70]. By 2020, roughly 9.8% of U.S. children had ever been diagnosed with ADHD by a healthcare provider (CDC data) [71]. Rates of adult ADHD diagnoses, at least for western English-speaking countries, did also increase; recent estimates suggest 4.4% of adults meet ADHD criteria [72], whereas in the past adult prevalence was thought to be around 2.5% [73]. This dramatic rise has spurred debate: are we simply recognizing and diagnosing ADHD better (correcting past underdiagnosis), or are we overdiagnosing normal behavior as ADHD? The answer appears to be both, depending on the context.

Some experts argue that ADHD is being overdiagnosed in certain populations. The broadening of diagnostic criteria over time (for example, DSM expanding allowable symptom presentations and raising the age of onset) could contribute to more marginal cases being labeled ADHD. Additionally, increased public awareness, to the point of ADHD trending on social media, may lead more individuals to seek diagnoses for relatively mild inattentiveness. There is worry that some

diagnoses are made too loosely, based on brief consultations or pressure from parents/schools, and that this can lead to unnecessary medication use. A 2022 review [74] noted concerns about "over diagnosis and over prescription of stimulant medications" for ADHD. Particularly in young children, normal high energy or behavioral problems stemming from other causes, like trauma or anxiety, might be misidentified as ADHD in haste. Research has shown factors like a child's age relative to classmates can influence diagnosis (younger, less mature children in a grade are more likely to be diagnosed with ADHD, suggesting some overdiagnosis of normal developmental differences). Overdiagnosis can carry risks: children might be stigmatized or exposed to medication side effects needlessly and healthcare resources might be diverted. Some clinicians also point out a trend of self-diagnosis via online checklists that may not be accurate, leading individuals to present to doctors convinced they have ADHD when they may not. All of this has led to calls for more careful, "thoughtful evaluation" [74] rather than quick labels. Nonetheless, it's important to quantify this carefully; the increase in numbers isn't proof of widespread misdiagnosis by itself, since it could reflect more people who truly needed help now getting it.

At the same time, ADHD remains underdiagnosed and under-recognized in certain groups, especially adults, females, and groups with little access to healthcare (economically poor, refugees, etc.). Historically, ADHD was considered a disorder of hyperactive little boys, and girls or quieter inattentive children were often overlooked. Many females with ADHD, often the predominantly inattentive type, never received a diagnosis in childhood and only discover it in adulthood when impairments accumulate. Similarly, societal biases and less access to care have meant that Black, Hispanic, and other minority children in the U.S. have lower rates of ADHD diagnosis and treatment compared to white children, despite similar prevalence, indicating underdiagnosis in those groups [74]. In adult psychiatry, until recently many clinicians were not trained to spot ADHD; adult patients often got diagnosed with depression or anxiety and the underlying ADHD went unaddressed [75]. One review called adult ADHD an "underdiagnosed, undertreated, and often comorbid" condition [75]. It is estimated that a large majority of adults with ADHD are not diagnosed or treated. Some experts have noted fewer than 20% of adults with ADHD receive an official diagnosis, meaning 80% remain undiagnosed [76]. This underdiagnosis has significant consequences: untreated ADHD in adults is associated with lower educational and occupational attainment [77], higher rates of substance use disorders, accidents [78], and even increased risk of criminal behavior in some cases [79]. On the positive side, increasing awareness has begun to chip away at this, the rise to ~6% adult prevalence in some estimates suggests more adults are being identified now than before.

The changes in DSM-5 (carried into DSM-5-TR) specifically addressed underdiagnosis in adults by making criteria more flexible for older ages. DSM-5 allows symptom onset by age 12 (instead of 7) and requiring only 5 symptoms for ages 17+ (instead of 6), these changes were meant to ensure adults who genuinely have ADHD aren't excluded just because they can't recall extreme symptoms in early childhood or because their hyperactivity has mellowed into restlessness. Research supports that these adjustments improve identification of adult ADHD without dramatically increasing false positives. Lowering the symptom threshold to 5 was shown to help identify known ADHD cases that would have been missed under the old rules [80]. In effect, this was a correction for previous underdiagnosis. However, broadening criteria does inherently raise the pool of diagnosable individuals, requiring clinicians to use clinical judgment about impairment and not diagnose based on checkbox count alone.

Current Perspective

The consensus in the field is that both overdiagnosis and underdiagnosis of ADHD occur, and the situation is nuanced. A Missouri review article [74] put it succinctly: there is simultaneous *"*debate and disagreement*"*, some worrying about overdiagnosis and stimulant misuse, others highlighting continued under-recognition in women and minorities, for example, ADHD was long under-detected in girls, contributing to a childhood male-to-female diagnosis ratio of roughly 3-4:1 that later converges to ~1:1 in adults [81]. The key is that overdiagnosis tends to be discussed in the context of relatively privileged populations (e.g. children in rigorous academic environments, or adults actively seeking diagnosis for performance issues), whereas underdiagnosis often refers to those who were overlooked (e.g. older adults who never got assessed, women whose symptoms were internalized, individuals in communities with less mental health access).

To put data to it: global prevalence of ADHD is estimated around 7.5% in children [82], yet some community samples in certain US states show nearly 16% being diagnosed [83], that gap suggests likely overdiagnosis in certain contexts. Conversely, population screening studies find a chunk of adults who screen positive for ADHD but never had been diagnosed or treated, as mentioned above. Both trends can co-exist.

One option to eliminate underdiagnosis is self-report questionnaires. However, large-scale evidence shows that relying on questionnaires alone is risky. A 2023 systematic review of 52 studies found that common adult self-report scales (e.g., the ASRS-v1.1, CAARS) produced false-positive rates as high as 86 % when ADHD base-rates were set at 5 %, meaning most people who screened "positive" did not meet full diagnostic criteria once formally evaluated [84].
Guideline-oriented reviews therefore frame rating scales as screening rather than diagnostic tools.

They recommend that positive screens always be followed by a structured clinical interview that can verify DSM-5 symptom thresholds, age-of-onset, impairment, and differential diagnoses [85]. Measurement-method comparisons reinforce this caution: in a three-level meta-analysis covering behavioral tasks, self-reports, and virtual-reality paradigms, self-report metrics showed the greatest heterogeneity and the widest confidence intervals, signaling lower precision relative to observer-based or performance-based indices [86].

Semi-structured diagnostic interviews (e.g., DIVA-5, CAADID, KSADS) offer that precision. The Korean validation of DIVA-5 reported a diagnostic accuracy of 92 %, with sensitivity = 91.3 % and specificity = 93.6 %, illustrating how a systematic probe of each DSM-5 criterion plus collateral history can sharply reduce both false-positives and false-negatives [87].
Field data echoes these psychometric findings. When the DIVA-5 served as the reference standard in an outpatient substance-use cohort, the widely used 6-item ASRS retained good sensitivity (83 %) but showed specificity ≤ 50 %, whereas the interview itself produced stable diagnoses and high patient acceptability, underscoring its pivotal role in complex presentations [88].

Therefore, clinicians are encouraged to strike a balance: be vigilant for ADHD where it truly exists but also ensure a thorough differential diagnosis and adherence to criteria to avoid over-labeling normal variance or other issues as ADHD. Using collateral information (school reports, childhood history) and ruling out trauma or anxiety as primary causes of attention problems are part of this careful approach.

4.4 Overdiagnosis Concerns vs. Under-recognition of PTSD

PTSD is unique among psychiatric diagnoses in that it requires a precipitating external event (trauma). The majority of people experience at least one traumatic event in their lifetime, by some estimates, 50% of individuals will be exposed to significant trauma [89]. However, only a minority of those go on to develop PTSD. Epidemiological studies indicate that the lifetime prevalence of PTSD (using DSM criteria) is on the order of 6.8% in the USA [89] and 3.9% globally [90]. This disparity, many experience trauma few get PTSD, is key to understanding over/underdiagnosis issues.

Historically, PTSD (especially in non-veteran populations) has often been underdiagnosed. Under-recognition is well documented in primary care settings. In a study of more than 600 urban primary-care patients, 23 % met DSM criteria for current PTSD, but clinicians had recorded the diagnosis in only 11 % of those cases; most undocumented cases were instead coded as depression or anxiety [91]. Screening studies in other primary-care samples find similar hidden prevalence ranging from 14 % to 32 % when structured interviews are used [92]. This highlights a tendency of

clinicians to misattribute PTSD symptoms to other disorders, such as sleep problems, low mood, and irritability might be assumed to be depression, when in fact they stem from PTSD. The presence of comorbid conditions can also lead the core PTSD to be overlooked. Underdiagnosis is particularly problematic because untreated PTSD can become chronic and debilitating, affecting relationships, physical health and daily functioning.

Certain populations are at risk of underdiagnosis: in children the symptom overlap with disorders such as ADHD or oppositional defiant disorder often leads to mislabelling [93], cultural minorities (language or cultural barriers may impede discussion of trauma) [94], and survivors of interpersonal violence (who may not volunteer their trauma history due to shame or fear) [95]. For children, clinicians might see aggression, poor concentration or emotional outbursts and diagnose ADHD or oppositional defiant disorder, missing that these could be trauma reactions [93]. Underdiagnosis also happens because some individuals don't seek help. Stigma around mental health or trauma, especially among military or first responders or in cultures that discourage talking about personal hardship, means many suffer PTSD symptoms without ever being evaluated.

On the other hand, PTSD has arguably become one of the most widely known psychiatric diagnoses, and some worry it is over-used or misused in situations that don't truly warrant it. The expansion of criteria in DSM (especially DSM-IV and DSM-5) fueled some of these concerns. For example, DSM-IV's relatively broad definition of what constituted a traumatic event (Criterion A) raised debates that normal grief or stress could be labeled PTSD if one stretched the concept of trauma. DSM-5 attempted to tighten Criterion A (requiring exposure to actual or threatened death, serious injury, or sexual violence, and excluding indirect exposures that are not work-related) to prevent over-labeling ordinary stressors as "trauma." Nonetheless, some experts like Joel Paris have argued that modern psychiatry tends to pathologize even normal reactions, and PTSD is cited as a diagnosis that may be given too readily in some cases [96]. Paris points out that not every emotional struggle after adversity is a psychiatric disorder, and warns against turning "life's misfortunes" into clinical diagnoses [96]. For instance, someone going through a rough divorce or job loss might have anxiety and insomnia, these are significant stressors, but unless they truly meet PTSD's trauma criteria and symptom pattern, calling it PTSD would be a misdiagnosis. Yet, in casual conversation and even by some clinicians, the term "PTSD" is at times applied loosely to mean any post-stress difficulty. This cultural penetration of the diagnosis increases risk of overdiagnosis.

Another context is the medicolegal realm: PTSD is often invoked in legal cases (disability claims, personal injury lawsuits, criminal defenses). Some psychiatrists note a tendency for "PTSD" to be used as a catch-all for any emotional harm after an event in legal settings which can lead to inflation

of the diagnosis beyond its clinical boundaries. In these cases, there may be incentives to diagnose PTSD (for compensation), possibly skewing diagnostic rigor.

PTSD's profile in media and society also contributes to potential overdiagnosis. With increased awareness about trauma, some individuals might self-diagnose or assume they have PTSD after a disturbing event [97]. While awareness is good, it can lead to confirmation bias: patients might report symptoms in line with what they think PTSD is or clinicians might lean towards PTSD if a trauma history is present even if the full picture fits another disorder (e.g., an individual with trauma history presenting mainly with generalized anxiety might be labeled PTSD by someone focusing too much on the past event). Since most people who experience trauma do not develop PTSD, it is incorrect to assume any psychological issue post-trauma is PTSD.

Importantly, acknowledging overdiagnosis issues should not detract from the reality that many PTSD cases are still going undiagnosed (which is the larger public health issue). Underdiagnosis means people suffer in silence or with misdirected treatment; overdiagnosis means some people might get unnecessary treatment or an inaccurate label. The ICD-11's approach is partly an attempt to reduce overdiagnosis by narrowing the criteria. DSM-5, conversely, was more concerned with not missing trauma-related psychopathology, thus risking some over-inclusiveness. The mental health field is actively researching how to find the optimal middle ground. For clinicians, best practice is to use standardized screening and assessments (like the PTSD Checklist or a structured interview) to improve diagnostic accuracy, and to always verify that the patient's symptoms and history meet each criterion for PTSD, rather than assuming. Additionally, being mindful of differential diagnosis helps avoid knee-jerk overdiagnosis.

PTSD's overdiagnosis and underdiagnosis issues are two sides of the same coin of diagnostic accuracy. The trend is that diagnoses of PTSD have risen since the 1980s (when it was first introduced) due to greater awareness but estimates of lifetime prevalence have remained in the single digits percentage-wise, suggesting we have not created an "epidemic" of PTSD in the general population beyond what is expected from trauma exposure rates.

4.5 Symptom Overlap Between ADHD and PTSD, and Comorbidity Challenges

ADHD and PTSD are very different disorders etiologically, one is largely genetic/neurodevelopmental, the other is triggered by external trauma, yet in clinical practice their symptoms can sometimes look similar and they also co-occur [1].

This is especially apparent in individuals who experienced childhood trauma. Trauma in early life can lead to chronic symptoms that resemble ADHD [98], and conversely individuals with ADHD

may be more prone to traumatic experiences, increasing their risk for PTSD. Distinguishing between the two and recognizing when both are present is a significant challenge for clinicians.

There is a surprising overlap in some symptomatology of ADHD and PTSD, which can confuse diagnosis if the patient's history is not fully understood.

Concentration difficulties in ADHD patients appear due to inherent attentional regulation problems. In PTSD, concentration can be impaired by intrusive memories or hypervigilance. A trauma-exposed individual might appear easily distracted but the cause could be trauma-related triggers or dissociation rather than a neurodevelopmental attention deficit. What seems like classic inattention could in fact be the person's mind avoiding traumatic memories or experiencing flashbacks [99].

ADHD is characterized by excessive fidgeting, an inability to stay still, and often impulsive motor activity (especially in children). PTSD can produce a state of hyperarousal, the person's nervous system is on high alert for danger. A hypervigilant person may also appear restless, jumpy or on edge, much like a hyperactive individual. For example, a child who survived a violent incident might be constantly scanning the environment, unable to sit calmly in class, a teacher might see this as ADHD-like hyperactivity.

ADHD often involves impulsive behavior: acting without thinking, interrupting, risk-taking, quick anger. PTSD, especially in children, can manifest as emotional dysregulation and irritability which is one of the DSM-5 arousal symptoms for PTSD. A traumatized person might have sudden anger outbursts or be described as impulsive, but the underlying cause could be trauma triggers or a constant fight-or-flight state. For instance, a child with PTSD might suddenly bolt out of a situation or lash out aggressively when reminded (even subtly) of their trauma, resembling the impulsivity or conduct problems sometimes seen in ADHD. In other words, a child's concentration suffers because they are on high alert for threats, not because of inherent ADHD deficits [100].

Children and adults with PTSD may actively avoid reminders of the trauma. In a classroom, a child avoiding thoughts of a traumatic event might tune out whenever something reminds them of it, appearing distracted. This avoidance-driven inattention is different from ADHD's baseline distractibility but can look the same externally. Also, PTSD can involve sensory hyper-reactivity, being easily startled by noises or movements which could be misconstrued as general distractibility similar to ADHD.

Table 3: Symptoms (PTSD/ADHD) and their overlap

Symptoms Unique to PTSD (DSM-5 Criteria B-E)	Overlapping Symptoms (shared diagnostic features)	Symptoms Unique to ADHD (DSM-5 Criteria A)
• Intrusive distressing memories / flashbacks • Recurrent trauma-related nightmares • Intense psychological or physiological distress at trauma cues • Persists in avoiding trauma thoughts, feelings, or reminders • Persistent negative beliefs, blame, or detachment • Marked diminished interest in activities • Inability to experience positive emotions • Hypervigilance & exaggerated startle response	• Difficulty concentrating / easily distracted • Restlessness or feeling "on edge" • Irritability or anger outbursts • Sleep disturbance • Reckless or impulsive behavior • Emotional lability / dysregulation	• Persistent inattention (sustaining focus, organizing tasks, follow-through) • Hyperactivity (fidgeting, unable to remain seated, excessive talking) • Impulsivity (blurting answers, difficulty waiting turn, interrupting others) • "On the go" or acts as if driven by a motor

*Sources [55][58]

Both conditions can impair executive functions like memory, planning, and self-regulation. Chronic trauma has been linked to difficulties in working memory and impulse control which are also core problems in ADHD (due to neurodevelopmental delays in frontal lobe maturation). Thus, tasks like organizing, completing projects or following multi-step instructions might be failed by both ADHD and PTSD patients, albeit for different reasons.

Because of these overlaps, misdiagnosis is a real risk. If a clinician is unaware of a patient's trauma history, they might see concentration problems, restlessness, and irritability and diagnose ADHD when the primary issue is PTSD (or acute stress). Conversely, if a clinician knows about a trauma, they might erroneously attribute all attention problems to PTSD, when the patient actually has lifelong ADHD that predates the trauma. A quote from the National Child Traumatic Stress Network emphasizes: "symptoms of child traumatic stress could be mistaken for ADHD and the risk of misdiagnosis is high… unless symptoms are examined closely, the profiles can appear similar" [101]. It is especially tricky in young children, who can't articulate internal states well, a young child doesn't say "I am hypervigilant and cannot concentrate because I feel unsafe," they just act

out or withdraw. Research indicates that many children with trauma get initially mislabeled as having ADHD [102].

Experiencing trauma in childhood can actually cause lasting changes that look like ADHD. Some studies have found that children with early trauma have higher rates of ADHD-like symptoms later on, even if they do not meet full PTSD criteria, possibly because chronic stress during development affects attention circuits. Children with actual ADHD who go through trauma tend to have worsening symptoms. They may develop full PTSD in addition to ADHD (one study noted children with ADHD were four times as likely to develop PTSD after trauma than non-ADHD peers) [103]. But even if they don't develop PTSD, the stress can exacerbate their attention and behavior problems. This bidirectional relationship means when trauma and ADHD co-exist, each can amplify the other [72]. A traumatized child with ADHD might become even more impulsive and inattentive; a child with trauma might appear to "acquire" ADHD. Clinically, one has to determine: did this child always struggle with attention (pointing to ADHD present before trauma), or did it begin after the trauma (pointing to trauma-related effects)? The requirement that ADHD symptoms start in childhood helps here, if an adult with trauma only began having ADHD-like symptoms after a traumatic event in adulthood, one should be skeptical of an ADHD diagnosis and consider that trauma is the primary cause.

Despite overlaps, there are key differences that can help distinguish ADHD from PTSD: symptoms by definition follow a traumatic event. ADHD is present from early childhood irrespective of external events. So a thorough history is crucial if attentional problems clearly existed long before any trauma (teachers noted it in early elementary years, etc.), ADHD is likely primary. If a patient with no prior ADHD history develops concentration and hyperarousal symptoms only after a traumatic incident, PTSD is the more likely explanation. However, note that adults with undiagnosed ADHD might only come to attention after trauma because the trauma made their life more chaotic, context is important but not absolute.

ADHD symptoms are fairly consistent across situations (though they vary with interest and structure of tasks). PTSD symptoms often fluctuate with triggers or reminders. For example, an adult with ADHD will be distractible almost always, whereas an adult with PTSD might focus fine in a safe, calm environment but then panic and lose focus when something reminds them of the trauma (e.g., a loud bang). If one notices that symptoms wax and wane with reminders, PTSD is indicated; if they are trait-like and pervasive, ADHD is indicated or both could co-occur.

ADHD inattention is often described as lack of persistence or easily bored, mind jumping to irrelevancies. PTSD inattention might be more of a mind that is preoccupied or deliberately

avoiding certain thoughts. A person with PTSD might also have memory gaps (psychogenic amnesia for parts of the trauma) or get lost in flashbacks, phenomena not seen in ADHD [104]. So asking about intrusive memories, nightmares, flashbacks, or trauma cues causing distress can uncover PTSD; their absence (with presence of life-long attention issues) leans to ADHD.

Hyperarousal content

Both may have sleep problems and irritability. PTSD's hyperarousal often includes nightmares of trauma, startle responses, and a general anxious vigilance. ADHD's hyperactivity is more generalized and not usually associated with fear; ADHD folks don't typically describe being "on guard" for danger, just feeling restless or impatient. So the subjective experience differs, anxious arousal vs. restless energy [105].

Avoidance and emotional numbing

PTSD uniquely features active avoidance of trauma-related stimuli and emotional numbing or negative mood specific to the trauma context. ADHD has no equivalent of avoidance (ADHD people don't avoid activities due to trauma reminders, though they might avoid tasks that are boring or hard, which is a different motivation). If someone avoids talking about a certain topic or going to a certain place and that avoidance started after a trauma, that is PTSD, not ADHD. Similarly, PTSD can cause a loss of interest in previously enjoyed activities (anhedonia related to trauma), which might look like inattention or apathy but is contextually linked to the trauma aftermath, ADHD does not cause that kind of emotional withdrawal (unless the person also becomes depressed) [104].

Developmental clues

In children, ADHD often has a genetic/familial pattern (other family members with ADHD, early temperament of hyperactivity). Trauma-caused issues will have an environmental precipitant. Also, ADHD diagnosed children, even if inattentive, usually can pay attention in one-on-one situations or on very reinforcing tasks, whereas trauma-affected kids might be unpredictable, having meltdowns or panic that seem unrelated to typical ADHD patterns.

Clinicians use these distinguishing factors, often supplementing with psychological testing or behavior questionnaires for ADHD, and trauma assessments for PTSD. It is recommended to screen for trauma in any child or adult who presents with ADHD symptoms that are atypical or if their history suggests adverse experiences. Likewise, when diagnosing PTSD, one should screen for pre-existing ADHD (for instance, by asking if they had attention/behavior problems prior to the trauma). As previously stated, "unless symptoms are examined closely," [101] the profiles can

appear similar, so careful assessment is key. The overlap means sometimes both diagnoses are appropriate, which leads to the issue of comorbidity.

Another option is to objectively assess a patient's mental state, for example, with the Quantified Behavioral Test (QbTest) which is a computerized continuous-performance task that pairs real-time infrared motion tracking with measures of response accuracy and latency to create objective indices of inattention, impulsivity and hyperactivity, benchmarked against age- and sex-matched norms [106]. A 2024 systematic review and meta-analysis found that these metrics raise diagnostic accuracy only modestly (pooled sensitivity ≈ 76 % and specificity ≈ 77 %), so QbTests should supplement, rather than replace, comprehensive clinical evaluation while offering a useful baseline for treatment monitoring [107]. Reflecting this evidence-based stance, the UK's National Institute for Health and Care Excellence approved routine deployment of QbTests in 2024, reporting that its inclusion can shorten the assessment pathway for 6- to 17-year-olds by up to six months [108].

4.6 Comorbidity and Influence on Diagnosis and Treatment

Research has increasingly shown that ADHD and PTSD can co-occur at higher-than-chance rates [1]. Having ADHD may predispose to developing PTSD. For example, individuals with ADHD might engage in more risk-taking behaviors or have impulsivity that leads them into dangerous situations, raising the likelihood of experiencing trauma [109]. They may also have more difficulty using coping strategies after trauma, perhaps due to executive function deficits, potentially increasing PTSD risk [110]. A recent study using genetic data (Mendelian randomization) provided evidence that genetic liability for ADHD increases the risk for developing PTSD after trauma, suggesting a partly causal relationship [111]. In that analysis, ADHD traits were not just correlating with PTSD, but appeared to contribute to it, even after accounting for common confounders like socioeconomic factors. Conversely, trauma (especially chronic trauma) can exacerbate ADHD or even reveal ADHD that was below diagnostic threshold, one can hypothesize that extreme stress might trigger a cascade that activates ADHD symptoms in those who are vulnerable. While trauma cannot create ADHD (in the sense of the core neurodevelopmental differences), it can certainly worsen attention and behavior, making ADHD more impairing, effectively creating a patient with previously subthreshold symptoms.

The prevalence of comorbidity varies by population, but studies indicate meaningful overlap. For instance, a sample of military veterans might show a few percent having both ADHD and PTSD, and those with childhood ADHD have a higher rate of adult PTSD if they experience combat [112]. The longitudinal military study found that soldiers with ADHD had higher odds of post-deployment PTSD, though overall the comorbidity rate was modest (around 1.7% had both at a given time, but

many more had one or the other). In clinical settings, comorbidity rates could be higher because those with multiple issues are more likely to seek help.

When ADHD and PTSD co-occur, diagnosis is challenging because each condition's symptoms can mask or be mistaken for the other (as discussed). Clinicians must decide whether criteria for both are fully met, which often involves parsing out the timeline and ensuring that the symptoms of one are not only during the course of the other. Technically, ADHD is lifelong, whereas PTSD has a start point at trauma. If a patient clearly has ADHD and then develops PTSD after an event, both diagnoses are given. If a patient has PTSD and only during PTSD do they show attention problems, one might decide not to diagnose ADHD unless evidence of childhood onset appears. Comorbidity can also lead to diagnostic overshadowing: a clinician aware of the PTSD might attribute everything to it and overlook ADHD, or an ADHD specialist might focus on ADHD and not inquire about trauma. One study noted that primary care doctors tended to mislabel patients with PTSD as having depression [92]; similarly, an adult ADHD clinic might mislabel someone as just ADHD when they actually also have PTSD if they don't assess trauma. Thus, integrated assessment protocols are recommended. For example, adult ADHD evaluations should include questions about trauma history, and PTSD assessments should ask about lifelong attention/impulse control issues.

When ADHD and PTSD co-occur, the individual's overall impairment is typically greater than with either disorder alone. Comorbidity often means more severe symptoms and additional problems: Patients with both conditions report higher levels of stress and may experience some symptoms synergistically. Comorbidity is associated with higher rates of other mental health issues like depression, substance abuse, and conduct problems [72]. One analysis found that in individuals with ADHD, those who had a PTSD diagnosis had significantly elevated risk of mood disorders, anxiety disorders, and conduct disorder compared to those ADHD individuals without PTSD [103]. This suggests a cluster of complex psychopathology when both are present.

Cognitive performance can be worse. ADHD already impairs attention and executive function; PTSD can affect memory and concentration as well. Together, studies in the meta-analysis by Scott et al. [113], have found cumulative effects, such as worse performance on memory tasks or more trouble in academic/work settings, for those with both diagnoses compared to either alone.

Both PTSD and ADHD are treatable, but traditionally the treatments differ (therapy and possibly SSRIs/alpha-agonists for PTSD; stimulants and coaching/therapy for ADHD). With comorbidity, clinicians often have to prioritize or combine interventions. One approach is to first stabilize the most acute symptoms. For example, if PTSD is causing severe nightmares and hyperarousal, treating that (with trauma-focused therapy or prazosin, etc.) might take precedence. Alternatively, if

ADHD is so severe that the patient cannot engage in therapy (due to inability to focus or restlessness), a stimulant medication might be introduced first to improve attention control so that PTSD therapy can proceed more effectively.

Interestingly, there is emerging evidence that some ADHD medications might help PTSD symptoms. A case report and small trials have suggested that the stimulant methylphenidate was associated with reductions in PTSD symptoms in some patients [114][115]. The proposed mechanism is that improving prefrontal cortex functioning and attention control with a stimulant may enhance extinction learning (the process needed to recover from trauma memories) and reduce impulsive re-experiencing. This is not yet standard practice, but it shows the potential for overlap in treatment, an ADHD drug helping PTSD or conversely, PTSD therapy helping ADHD-related emotional impulsivity. Nonetheless, caution is warranted: stimulants can also increase anxiety and insomnia, which might exacerbate PTSD, so each patient's response has to be monitored.

Evidence-based therapies for PTSD, such as Cognitive Behavioral Therapy (CBT) (specifically trauma-focused CBT like cognitive processing therapy) and Eye Movement Desensitization and Reprocessing (EMDR), can be effective even if the patient has ADHD, but the therapist may need to adapt techniques to account for ADHD (for instance, shorter sessions or more engaging methods to sustain attention). Likewise, ADHD-focused therapy (like organizational skills training) might need to integrate trauma-informed strategies (because standard ADHD coaching might not consider triggers that derail the patient due to PTSD).

The ideal is an integrated treatment plan that addresses both. As an example, a patient might concurrently take a stimulant for ADHD and attend a trauma therapy group for PTSD. Or a sequence: treat acute PTSD symptoms to remission, then tackle residual ADHD issues. There is no one-size-fits-all sequence; clinicians often go by severity. Whichever disorder is causing more immediate dysfunction is addressed first, while keeping the other in mind. Collaboration between specialists (e.g., a psychiatrist for medication and a psychologist for therapy) can ensure neither condition is neglected.

Patients with both ADHD and PTSD often benefit from additional support structures, such as stress management techniques, sleep hygiene, and perhaps family therapy if family dynamics are affected. It's important for the patient and family to understand both disorders.

While having both ADHD and PTSD can complicate treatment, patients can and do improve with proper care. That said, comorbidity is often linked to a more protracted course and the need for longer or more intensive intervention [116]. This underscores the importance of early identification of both conditions. For example, a child with ADHD who experiences trauma should ideally receive

early trauma-focused intervention. This might prevent the development of full PTSD or lessen its severity. Similarly, a traumatized child should be evaluated for pre-existing ADHD to ensure that condition is managed; otherwise, they may not fully benefit from trauma therapy.

4.7 Neurological Structural and Functional Changes

ADHD (Adult)

Converging evidence from neuroimaging indicates that adults with attention-deficit/hyperactivity disorder (ADHD) exhibit subtle but widespread structural brain differences. Voxel-based morphometry and volumetric MRI studies show reduced total cortical gray matter volume in ADHD, with particularly smaller volumes in the prefrontal cortex and anterior cingulate cortex (ACC) compared to controls [117][118]. For example, Seidman et al. reported that adults with ADHD have significantly smaller dorsolateral prefrontal and ACC volumes (after adjusting for overall brain size) relative to healthy adults [118]. Large-scale collaborative analyses reinforce these findings: the ENIGMA consortium mega-analysis (combined children and adults) found that ADHD is associated with small but significant reductions in subcortical volumes, including the amygdala, hippocampus, nucleus accumbens, caudate, and putamen, as well as smaller total intracranial volume [122]. Notably, these volumetric differences tend to be more pronounced in youth and attenuated in adults [122], suggesting partial normalization or compensatory brain development by adulthood (consistent with the clinical observation that some ADHD symptoms remit with age). Functionally, task-based fMRI studies in adult ADHD patients have consistently demonstrated hypoactivation in frontal regions and ACC during attention-demanding or inhibitory control tasks [118]. Meta-analyses indicate that adults with ADHD under-recruit fronto-parietal executive networks (e.g. dorsolateral prefrontal cortex) during cognitive tasks, which correlates with their impairments in attention and executive function [118]. Likewise, reduced activation of the dorsal ACC during tasks requiring conflict monitoring or inhibition has been observed, reflecting ACC dysfunction in ADHD's core symptoms [117][120]. Taken together, these structural and functional alterations support models of adult ADHD as a disorder of delayed or diminished maturation in neural circuits subserving attention and cognitive control [117][118].

PTSD (Adult)

Patients with post-traumatic stress disorder (PTSD) also show characteristic neuroanatomical changes [121], some of which overlap with those seen in ADHD but others of which are distinct. Perhaps the most replicated finding is reduced hippocampal volume in PTSD. Meta-analyses of MRI studies have confirmed that adults with PTSD have significantly smaller hippocampi than trauma-exposed controls without PTSD [122][123]. For instance, a multisite ENIGMA-PGC study

of ~800 PTSD patients and ~800 trauma-exposed controls found an overall 5–6% smaller hippocampal volume in those with current PTSD [122]. This effect is present in both adult men and women with PTSD and is thought to reflect stress-related neuronal loss or inhibited neurogenesis in the hippocampus (a brain region critical for context-related memory and stress regulation). In addition, volumetric reductions have been observed in the ventromedial prefrontal cortex (vmPFC) and ACC in PTSD [45][123]. A systematic review by O'Doherty et al. noted bilateral volume reductions of the ACC in PTSD relative to both non-traumatized and traumatized controls [45]. Amygdala volume findings have been more variable, but some analyses (especially in combined samples of children and adults) report a modest reduction in amygdala volume in PTSD [122][123], though trauma exposure alone can also contribute to amygdala changes. Beyond structure, PTSD is characterized by pronounced functional abnormalities in fronto-limbic circuits: hyperactivation of the amygdala (and related limbic regions) in response to threat or trauma reminders, coupled with hypoactivation of the prefrontal cortex during tasks requiring emotion regulation or extinction recall [123][119][121]. Functional neuroimaging meta-analyses demonstrate this pattern clearly. Hayes et al. found that PTSD patients show hyperactivation in the mid/dorsal ACC and amygdala during symptom provocation, but widespread hypoactivation in the vmPFC and orbitofrontal regions during cognitive-emotional tasks [119]. This aligns with the prevailing neurocircuitry model of PTSD in which an overactive "fear network" (amygdala and mid-cingulate/insula) is insufficiently regulated by a weakened prefrontal inhibitory system [123]. In practical terms, PTSD patients fail to engage frontal cortical control, resulting in exaggerated amygdala responses to trauma-related cues and impaired extinction of fear [123][121]. Structurally, this may be underpinned by the reduced volume and neuronal integrity of vmPFC/ACC noted above. In sum, adult PTSD is associated with both structural shrinkage in key limbic and prefrontal regions and functional dysregulation of neural circuits for fear and stress responses [45][123][119].

Comorbidity and Overlap

Individuals suffering from both ADHD and PTSD represent a convergence of these neurobiological abnormalities. Studies suggest ADHD significantly increases the risk of developing PTSD after trauma exposure (with ~28–36% of adult ADHD patients meeting PTSD criteria in some samples) [1]. Neurobiologically, this comorbidity may manifest as additive or interactive deficits: for example, an adult with both ADHD and PTSD might exhibit the fronto-striatal underdevelopment of ADHD and the fronto-limbic abnormalities of PTSD. Both disorders involve abnormalities in frontal and cingulate cortices, suggesting this region is a critical overlap. Indeed, dysfunction of the ACC is implicated in both ADHD's attention deficits and PTSD's emotion regulation failures. Comorbid patients may therefore have compounded ACC deficits, potentially explaining their

greater symptom severity observed clinically (e.g. more severe PTSD symptoms and worse functional outcomes have been reported in PTSD patients with comorbid ADHD) [1]. Additionally, hippocampal volume loss and impaired memory (from PTSD) in an ADHD patient could exacerbate attentional and executive problems. While direct neuroimaging studies of comorbid adult ADHD+PTSD are still scarce, it is hypothesized that these patients show more extensive structural reductions (spanning prefrontal, cingulate, and medial temporal regions) and greater functional network disruptions than patients with either disorder alone [123][121]. Abnormal neural fear circuitry could also link the conditions, for instance, deficits in top-down control (from ADHD) may leave one more vulnerable to developing persistent fear responses (PTSD) after trauma [120]. Overall, the comorbidity likely reflects an interplay of shared vulnerabilities (like inefficient prefrontal control networks) and disease-specific changes, producing a more severe neurobiological phenotype.

Emotional dysregulation (Neurodevelopmental origins)

Emotional dysregulation (ED), difficulties modulating anger, frustration or irritability, is common in ADHD. Approximately 25-45% of children with ADHD have pronounced ED [124]. Shaw and colleagues describe ED in ADHD as pervasive across the lifespan and a major source of impairment. Neurobiological models suggest ADHD-related ED arises from dysfunction in frontal–striatal–amygdala circuitry that normally regulates emotion [125]. Whether ED is a core feature or a correlated trait is debated, but it clearly exacerbates ADHD: co-twin analyses show that the twin with ADHD has higher ED than their non-ADHD co-twin, and this association is stronger in dizygotic pairs than monozygotic pairs [124], implying that the ADHD–ED link is partly genetic.

Early temperament and longitudinal studies reveal ED-related markers in those who develop ADHD. Infants at high familial risk for ADHD show elevated “negative emotionality” by 6 months, e.g. intense anger/irritability in response to restraint or limitations [125]. In the study, infants with ADHD-affected parents had more distress and anger to challenges than low-risk infants. Similarly, preschoolers rated high in anger/frustration are more likely to have severe ADHD later. Rabinovitz et al. found that parent-reported anger/frustration at age 3-4 strongly predicted ADHD symptom severity at age 7, even after accounting for executive function [127]. These longitudinal findings suggest a developmental cascade: early reactive temperament (ED) may impair emerging cognitive control, contributing to ADHD symptoms. Miller et al. likewise highlights that infants with negative affect and low attentional control show familial ADHD risk very early [128].

In sum, ADHD and its associated ED generally have their roots in early neurodevelopment. Environment (e.g. parenting, stress) modulates the outcome but does not fully account for ADHD

onset [129]. Therefore, children with ADHD are effectively neurodiverse from the outset. Their emotional dysregulation emerges as part of the neurodevelopmental syndrome, rather than arising only from later experience. Early screening for temperamental ED and interventions to support emotion regulation in at-risk children may therefore help mitigate the severity of ADHD outcomes [127].

Emotional dysregulation (ADHD+PTSD comorbidity)

Posttraumatic stress disorder is fundamentally a disorder of emotion dysregulation. PTSD symptoms reflect both extremes of dysregulation: intrusive re-experiencing and hyperarousal indicate under-regulation, whereas emotional numbing, avoidance, and dissociation represent over-regulation [130]. In adolescents with severe PTSD, neuroimaging reveals aberrant development of prefrontal–amygdala circuits that normally inhibit fear and regulate emotion, consistent with dysregulation [131]. Clinically, PTSD often includes chronic irritability, angry outbursts, and mood lability (DSM-5 Criterion E), reflecting impaired affective control. Emotional dysregulation is not only a consequence of trauma but also a risk factor: pre-existing difficulties in emotional clarity and regulation heighten PTSD risk and symptom severity [130].

When PTSD occurs with comorbid ADHD, emotional dysregulation tends to worsen. ADHD is a documented risk factor for developing PTSD after trauma [103]. Mechanistically, overlapping neurocircuits may underlie the compounded dysregulation. Both ADHD and PTSD involve deficient prefrontal modulation of amygdala reactivity [125]. Children with ADHD are more likely to meet PTSD criteria if exposed to trauma, and ADHD symptoms (like impulsivity) correlate with higher risk of PTSD in clinical samples [103].

2.8 Key Brain Regions: ACC, PFC, and DMN

Anterior Cingulate Cortex (ACC)

The ACC is a pivotal region for both cognitive attention control and emotion regulation, and it is implicated in the pathophysiology of ADHD and PTSD alike. In adult ADHD, structural MRI consistently finds reduced volume or thickness of the dorsal ACC (part of the cognitive division) [117][22]. Cortical thinning in the ACC and adjoining medial prefrontal areas has been observed in adults with childhood-onset ADHD [123][132]. Functionally, ADHD patients often show hypoactivation of the dorsal ACC during tasks requiring conflict monitoring or sustained attention[117][120]. Bush et al. reported ACC under-engagement in ADHD during a Stroop task, suggesting “anterior cingulate cortex dysfunction” contributing to core ADHD symptoms of inattention and impulsivity [283]. This ACC hypoactivity is thought to underlie ADHD individuals’

difficulties in error detection and inhibiting prepotent responses. In PTSD, a somewhat different pattern emerges: the ventral/rostral ACC (part of the vmPFC) is typically underactive and sometimes structurally smaller [45][119], which corresponds to a deficit in top-down inhibition of the amygdala's fear output. At the same time, some studies find hyperactivation of the dorsal ACC (mid-cingulate) in PTSD, potentially reflecting an exaggerated alarm signal or effortful attempt to regulate fear that nonetheless fails [119]. For instance, a meta-analysis found PTSD patients had increased activation in mid/dorsal ACC during symptom provocation (perhaps reflecting heightened salience of trauma cues), alongside decreased activation of the rostral ACC during cognitive regulation tasks [119]. Structurally, PTSD has been associated with reduced volume of the subgenual ACC (sgACC) [45], a region important for emotional appraisal and extinction learning. In comorbid ADHD/PTSD, ACC abnormalities may be compounded – an individual might have the smaller, hypoactive dorsal ACC seen in ADHD as well as an impaired ventral ACC from PTSD. This convergence could manifest as severe problems in both cognitive control and emotional regulation. Notably, both disorders' treatments often engage the ACC: stimulant medications can increase ACC activation in ADHD [120], and successful PTSD therapies (exposure therapy, EMDR, etc.) have been shown to normalize rostral ACC function as patients learn to modulate fear [133]. Thus, the ACC is a key node where the neurocircuitry of ADHD and PTSD intersect, with dysfunction in this region contributing to attentional lapses, impulsivity, and exaggerated fear/anxiety symptoms [123][121].

Prefrontal Cortex (PFC)

The prefrontal cortex, particularly the dorsolateral and ventromedial sectors, is central to executive function and emotion regulation. In ADHD, decades of research have emphasized prefrontal abnormalities. Structurally, adults with ADHD tend to have a smaller total frontal lobe volume (including reductions in dorsolateral PFC gray matter) [117][118] and less complex gyrification of frontal cortices [132]. Task-based fMRI consistently reveals hypoactivation of the dorsolateral PFC during tasks requiring sustained attention, working memory, or inhibitory control [118][119]. These findings align with the classic view of ADHD as a disorder of prefrontal executive dysfunction. Furthermore, cortical development studies have shown a delay in PFC maturation in ADHD, the typical peak in cortical thickness is reached a few years later in children with ADHD than in peers [21], potentially translating into functional deficits persisting into adulthood. In PTSD, prefrontal disturbances are more biased toward the medial and orbitofrontal regions involved in emotion. The ventromedial PFC (vmPFC), encompassing the medial PFC and orbitofrontal cortex, is often hypoactive in PTSD during tasks such as extinction recall or emotion regulation [123][119]. For example, when PTSD patients try to suppress fear responses, they show insufficient vmPFC

activation and fail to adequately downregulate limbic activity [123]. Structural imaging also suggests subtle reductions in vmPFC volume or cortical thickness in PTSD populations [45][123]. Notably, the PFC differences in PTSD are often context-dependent: under resting or neutral conditions, some PTSD patients may actually show increased medial PFC metabolism (possibly related to chronic disengagement from external stimuli or "depersonalization"), whereas during cognitive-emotional challenge their vmPFC fails to activate normally [121][134]. In the context of comorbidity, a patient with ADHD+PTSD likely experiences deficits in both lateral PFC (manifesting in poor concentration, disorganization) and medial PFC (manifesting in poor emotional modulation and excessive fear). These combined PFC abnormalities could explain observations that comorbid patients have more severe functional impairments[1]. The PFC's integrity is crucial for both disorders, and interestingly, therapeutic interventions often target PFC function: stimulant medication in ADHD can improve lateral PFC activity and connectivity [135], while cognitive-behavioral therapies for PTSD aim to strengthen vmPFC-mediated extinction of fear. Neuroimaging of treated patients shows that alleviation of PTSD symptoms is accompanied by increased vmPFC activation and connectivity with the hippocampus/amygdala [133][121], essentially "restoring" some prefrontal regulatory control. This underscores how central PFC dysfunction is to both ADHD and PTSD pathology and recovery.

Default Mode Network (DMN)

The default mode network is a set of midline brain regions (medial PFC, posterior cingulate cortex (PCC)/precuneus, and angular gyrus) that activate during rest and mind-wandering and typically deactivate during externally-focused tasks. Both ADHD and PTSD have been linked to atypical DMN functioning, albeit in different ways. In ADHD, there is evidence of poorly regulated DMN activity, patients may struggle to appropriately suppress the DMN when they need to concentrate, leading to lapses of attention or mind-wandering during tasks [284]. Resting-state fMRI studies of ADHD have found abnormal functional connectivity within the DMN and between the DMN and task-positive networks [135]. For example, one study reported that adolescents with ADHD showed reduced internal DMN connectivity but increased cross-talk between the DMN and frontoparietal task networks, and these aberrations correlated with greater mind-wandering and impulsivity [284]. This suggests that the DMN intrudes during goal-directed activity in ADHD, consistent with the idea that ADHD's inattentiveness is partly due to an overly active default-mode (internal thought) state [284]. Indeed, Castellanos and colleague hypothesized an "default mode interference" model for ADHD, where an inability to appropriately modulate the DMN leads to attentional fluctuations [285]. By contrast, in PTSD, the DMN's connectivity patterns often reflect difficulties with self-referential processing and memory integration related to trauma. Some PTSD studies have observed

reduced connectivity within the DMN, for instance between the posterior cingulate and hippocampus (a key DMN node in the medial temporal lobe) [139]. Miller et al. found that combat veterans with PTSD had significantly lower functional connectivity between the PCC and hippocampus than trauma-exposed controls, suggesting a disruption in the DMN's memory-related subsystem [136]. This reduced PCC–hippocampal coupling was interpreted as impaired contextual processing (the ability to situate memories of the trauma in time/place) in PTSD. Other research has shown that lower DMN connectivity is associated with more severe PTSD dissociative symptoms [286]. Paradoxically, some PTSD patients, especially those with re-experiencing symptoms, can exhibit excessive activation of certain DMN regions (like medial PFC) during rest, possibly reflecting ruminative, internally-focused attention on traumatic memories [141][142]. Overall, PTSD appears to involve disrupted DMN modulation, either as hypo-connectivity (fragmented internal narrative) or aberrant activation (intrusive memories and self-focused rumination). In individuals with both ADHD and PTSD, DMN abnormalities could be quite pronounced. They may experience intrusive trauma-related thoughts (a PTSD feature) combined with the spontaneous mind-wandering of ADHD, indicating that DMN hyperactivity and dysregulation is likely a core issue. While direct studies are lacking, it is reasonable to speculate that comorbid patients have difficulty toggling between the default mode and task-positive states, resulting in attentional lapses and uncontrollable trauma recollections. Intriguingly, treatments for both disorders can alter DMN dynamics. Mindfulness training, which has shown benefit in both ADHD and PTSD, is thought to increase DMN coherence and improve the ability to disengage from distracting internal thoughts [1][142]. Neurofeedback training (in ADHD) targeting increased sensorimotor rhythm and reduced theta (which indirectly affects DMN) has led to improved attention and could potentially be applied to PTSD as well to stabilize DMN activity. In summary, the DMN, governing our "resting mind", is improperly regulated in ADHD and PTSD, contributing to symptoms like mind-wandering, dissociation, and intrusive memories, and thus represents a crucial network in understanding their comorbidity [139][142].

4.9 Neurotransmitter Dysregulation (Dopamine, Norepinephrine, Glutamate, GABA)

ADHD Neurotransmitters

ADHD has long been linked to disruptions in catecholamine signaling, particularly dopamine (DA) and norepinephrine (NE), which are key neurotransmitters in prefrontal-striatal circuits. Biochemical and imaging studies indicate that adults with ADHD have reduced dopaminergic activity in brain reward and attention pathways. PET scans using radioligands for dopamine receptors and transporters have shown that unmedicated adults with ADHD exhibit abnormally low availability of striatal D2/D3 dopamine receptors as well as elevated dopamine transporter (DAT)

levels [134][143]. Volkow et al. reported that adults with ADHD had significantly lower D2/D3 receptor binding in the nucleus accumbens and midbrain, along with higher DAT binding, compared to controls, consistent with a state of dopamine deficit (since more DAT can overly clear DA from synapses) [134]. This dopaminergic hypofunction correlates with ADHD symptoms: for instance, lower D2 receptor levels are associated with greater inattention and impulsivity [134]. Moreover, stimulant medications like methylphenidate, which block DAT and increase synaptic dopamine, tend to normalize these PET findings and alleviate symptoms, reinforcing the central role of dopamine. Parallel evidence implicates norepinephrine dysregulation in ADHD. NE is crucial for sustaining attention and modulating arousal via its actions in the frontal cortex. ADHD was actually the first disorder identified as a "noradrenergic deficiency" in early theories [144], and current treatments (e.g. atomoxetine) enhance NE signaling. Clinical neurochemistry studies have found low baseline NE metabolites in some ADHD patients and blunted NE responses to cognitive challenges. Functionally, both DA and NE are needed for optimal prefrontal cortex function, and a shortage of these catecholamines in ADHD may lead to the noisy, inefficient signaling observed in the disorder [145]. Notably, dopamine-norepinephrine interactions are important: dopamine in the striatum handles reward/motivation, while prefrontal NE helps focus signal-to-noise for attention [145]. The catecholamine hypothesis of ADHD is supported by genetics as well (with many ADHD-risk genes affecting dopamine or NE pathways, discussed later). Beyond catecholamines, emerging data suggest ADHD involves an imbalance in excitatory and inhibitory neurotransmitters, namely glutamate and GABA. Magnetic resonance spectroscopy (MRS) studies have observed altered levels of glutamate (Glu, the primary excitatory neurotransmitter) and GABA (the main inhibitory transmitter) in the brains of those with ADHD [146]. For example, one spectroscopy study found that while performing an attention task, adults with ADHD failed to show the normal increase in ACC GABA levels that controls exhibit, indicating an insufficient GABAergic response during cognitive control exertion [287]. Other MRS research has reported elevated glutamate+glutamine concentrations in frontal-striatal regions of children with ADHD [147] and reduced GABA in the striatum of adolescents with ADHD [146]. These findings point to an excitation/inhibition imbalance in ADHD: excessive glutamatergic activity (or inefficient synaptic pruning) in some circuits, coupled with inadequate GABAergic tone in others. Such a neurochemical profile could contribute to cortical hyperactivity (and thus distractibility) and poor inhibitory control at the neural level. In summary, adult ADHD is characterized by catecholamine hypo-function (low DA and NE signaling) along with more subtle glutamatergic/GABAergic dysregulation, resulting in the brain being under-stimulated in areas of focus but overactive in uncontrolled ways. This cocktail of neurotransmitter abnormalities underlies the inattentiveness, impulsivity, and executive dysfunction

of ADHD, and it explains why medications that boost DA/NE (stimulants) or modulate NE (atomoxetine) are effective treatments.

PTSD Neurotransmitters

The neurochemistry of PTSD is dominated by an overactivation of stress-response systems, most prominently the noradrenergic system. PTSD patients often exhibit elevated central and peripheral norepinephrine levels, reflecting a state of chronic "fight-or-flight" hyperarousal. Multiple studies have found that individuals with PTSD have higher concentrations of NE and its metabolites in their cerebrospinal fluid and blood compared to controls [148]. For instance, Geracioti et al. reported that combat-related PTSD patients had significantly higher CSF NE levels (roughly 30% greater) than healthy men [149]. A meta-analysis by Pan et al. confirmed that across studies, PTSD is associated with significantly increased NE concentrations (pooled effect showing higher NE in PTSD vs trauma-exposed controls) [148]. This NE excess originates from hyperactivity of the locus coeruleus (LC)–noradrenergic system, which is the brain's primary NE source. Indeed, recent neuromelanin-sensitive MRI imaging of the locus coeruleus in PTSD has directly shown increased LC signal (a proxy for heightened LC neuron activity or number) in PTSD patients [150]. Functionally, an overactive noradrenergic system contributes to PTSD symptoms such as hypervigilance, exaggerated startle, anxiety, insomnia, and intrusive memories (NE strengthens memory consolidation under stress, which may solidify traumatic memories) [151]. Clinically, drugs that dampen NE signaling (like prazosin, an alpha-1 blocker, or propranolol, a beta-blocker) can reduce PTSD nightmares and hyperarousal, underscoring NE's role. Dopamine also appears to be involved in PTSD, though its role is less elucidated than NE's. Some PTSD symptoms (numbed pleasure, risky behavior) hint at altered dopamine in the reward circuit. Genetic evidence suggests that certain dopamine receptor polymorphisms confer risk for PTSD. Notably, early studies found that Vietnam veterans with PTSD were far more likely to carry the D2 dopamine receptor A1 allele (a variant associated with reduced D2 receptor density) than those without PTSD [152]. In one sample, 60% of PTSD patients had the DRD2 A1 allele versus only ~5% of trauma-exposed controls, a striking association [152]. This has been replicated in other cohorts; for example, a DRD2 957C>T variant was associated with increased PTSD severity in war veterans [153]. These findings imply that lower dopaminergic tone (as conferred by these gene variants) may predispose individuals to develop PTSD after trauma, possibly by diminishing the prefrontal dopamine needed to extinguish fear or by enhancing the salience of threat via subcortical circuits. Additionally, some PET studies point to dopamine changes in PTSD, e.g. one study showed PTSD patients had altered striatal dopamine transporter binding and blunted dopamine release in response to amphetamine, consistent with "depressed" dopamine activity in certain pathways [151]. On the other hand,

dopamine surges in acute trauma (facilitated by NE) might imprint fear memories. Thus, while the noradrenergic system is clearly hyperactive in PTSD, the dopaminergic system may be somewhat dysregulated as well (perhaps initially increased during trauma, then diminished in chronic PTSD, particularly in reward pathways contributing to anhedonia). Beyond catecholamines, PTSD involves disruptions in the balance of excitatory and inhibitory neurotransmission. Extreme stress and recurrent trauma exposure can lead to glutamate-mediated neurotoxicity and GABAergic interneuron dysfunction. Some MRS studies in PTSD have found elevated glutamate levels in the medial prefrontal cortex and ACC of PTSD patients, suggesting heightened excitatory drive in circuits that may underlie persistent fear conditioning [154]. Simultaneously, GABA activity appears to be reduced in PTSD, preclinical studies indicate stress can cause loss of GABAergic inhibition in the amygdala, resulting in unchecked fear responses. Clinical data align with this: one recent review concluded that GABAergic function is decreased in PTSD, evidenced by lower cortical GABA levels (especially in those with poor sleep or high hyperarousal) and by the efficacy of GABA-modulating medications (like benzodiazepines or gabapentin) in some PTSD patients [141][151]. For example, Meyerhoff et al. observed that PTSD patients with insomnia had significantly lower occipital cortex GABA, linking GABA deficits to symptoms [185]. Taken together, PTSD can be seen as a state of excessive excitation and insufficient inhibition in the brain: too much NE and glutamate fueling hyperarousal and fear memory consolidation, and not enough GABA to quell the resulting overactivity [141]. This neurochemical profile explains why PTSD is often treated with drugs targeting these systems, e.g. prazosin (to reduce central NE), certain anticonvulsants (to enhance GABAergic tone), or d-cycloserine (a NMDA partial agonist to facilitate extinction learning via glutamatergic pathways).

Comorbidity Considerations

In patients with both ADHD and PTSD, complex neurotransmitter interactions are likely at play. ADHD's baseline catecholamine deficits could theoretically exacerbate PTSD symptoms, for instance, low dopamine may impair extinction learning, making PTSD more persistent, while low prefrontal NE might worsen concentration and increase susceptibility to intrusive thoughts. Conversely, PTSD's chronically high NE could aggravate ADHD symptoms of impulsivity and emotional lability (as NE also modulates mood and response inhibition). Interestingly, some overlapping pharmacotherapies hint at synergy: for example, adrenergic alpha-2 agonists (like guanfacine) can improve ADHD symptoms by enhancing prefrontal NE signaling, and they also have anti-hyperarousal effects in PTSD by damping LC output. Similarly, stimulant medications that elevate dopamine/NE have been noted in case reports to sometimes help with PTSD cognitive symptoms (though they risk increasing anxiety in others). Comorbid patients might benefit from

treatments addressing both domains, e.g. a combination of stimulant (for ADHD attentional improvement) and prazosin (for PTSD hyperarousal/nightmares) – underscoring how balancing neurotransmitters is crucial. Ultimately, ADHD+PTSD patients likely experience a dual dysregulation: an inherent underactivity in certain neurocircuits (ADHD-related DA/NE deficits in focus networks) coexisting with an acquired overactivity in stress circuits (PTSD-related NE/glutamate surges and GABA declines). This dual imbalance can feed on itself; for instance, high stress NE can further impair executive control, and poor executive control can lead to more traumatic exposures or poor coping, continuing a vicious cycle. Effective management of such patients requires careful modulation of these neurochemical systems to restore equilibrium [151].

4.10 Neuroimaging Evidence (fMRI, PET, and Resting-State)

Functional MRI (Task-Based)

Functional neuroimaging has provided a window into the real-time brain dysfunctions underlying ADHD and PTSD. In ADHD, numerous fMRI studies using cognitive tasks have demonstrated underactivation of key attention and executive networks. Adults with ADHD show reduced activation in the fronto-parietal network, including lateral prefrontal cortex, dorsal ACC, and inferior parietal lobules, during tasks of sustained attention, inhibition (e.g. Go/No-Go), and working memory [118]. This hypoactivation is often accompanied by aberrant recruitment of other regions; for example, ADHD subjects might inappropriately activate default-mode or visual regions when they should be engaging frontal regions for a task [118]. Meta-analyses of fMRI data confirm a pattern of hypofunction in dorsolateral PFC, ACC, and basal ganglia during inhibitory control tasks in ADHD, correlating with the severity of impulsivity [118]. By contrast, in PTSD, task-based fMRI typically highlights hyper-responsivity of limbic regions and hypo-responsivity of cortical regulatory regions [119]. During symptom provocation (e.g. viewing trauma-related images or listening to combat sounds), PTSD patients reliably activate the amygdala, insula, and mid-cingulate to a greater degree than controls, reflecting exaggerated fear and salience responses [123][119]. Simultaneously, they often fail to activate the vmPFC and rostral ACC as controls do, indicating an absence of top-down damping of those fear responses [123][121]. In fear-conditioning experiments, individuals with PTSD show heightened amygdala activation during acquisition and deficient activation of vmPFC during extinction recall, paralleling their behavioral failure to extinguish fear [123]. Interestingly, in some cognitive tasks not involving emotional stimuli, PTSD patients can show hyperactivation of the dorsal ACC or lateral PFC, possibly as an effortful (but inefficient) compensation for deficits or as a generalized “alarm” state. For instance, some PTSD studies find increased dorsal ACC activation even during simple concentration tasks, which may represent an underlying anxious hypervigilance that intrudes into cognitive processing [119]. Taken

together, fMRI studies paint complementary pictures: ADHD as a condition of under-engagement of control networks, and PTSD as a condition of over-engagement of threat networks (with under-engagement of control when trying to regulate emotion). In comorbid cases, one might expect to see both patterns: e.g., on a cognitive task, a patient with ADHD+PTSD might both struggle to recruit frontal focus networks (due to ADHD) and concurrently exhibit hyperactive limbic responses if the task stimuli are even mildly stressful or trauma-reminding (due to PTSD). The net effect could be marked performance impairments and unique brain activation profiles that are an amalgam of both disorders. This is an important area for future fMRI research, as understanding the combined activation patterns could inform tailored interventions (for example, whether to emphasize stimulants to boost frontal activation or anxiolytics to tone down limbic activation, or both).

Positron Emission Tomography (PET) and SPECT

In ADHD, PET work with the DAT-selective ligand ^11C-altropane demonstrated ≈14 % higher striatal dopamine-transporter binding in unmedicated adults with ADHD relative to matched controls [143], whereas parallel PET studies using ^11C-raclopride showed about a 10 % reduction in D2/D3-receptor availability in the same circuitry [156]. The earliest FDG-PET study of the disorder found an 8 % global hypometabolism, with the largest drops in premotor and superior prefrontal cortices [157]. A quantitative meta-analysis pooling nine PET/SPECT series confirmed a mean 14 % elevation of striatal DAT signal, most pronounced in previously medicated samples, reinforcing transporter dysregulation models [158].

In PTSD, resting FDG-PET repeatedly reveals limbic hypermetabolism (right amygdala, mid-cingulate, thalamus) alongside orbitofrontal hypometabolism, indicating a threat-primed but weakly regulated network [159]. Trauma-provocation paradigms further depress medial-prefrontal perfusion while boosting retrosplenial/posterior-limbic responses, reproducing the classic "mPFC-down/limbic-up" signature [160]. More recently, neuromelanin-sensitive MRI (and hybrid PET/MR) has shown significantly elevated locus-coeruleus signal in military veterans with PTSD, scaling with CAPS-5 hyperarousal severity and directly implicating noradrenergic overdrive [161]. Molecular PET extends beyond catecholamines: ^11C-flumazenil studies demonstrate globally reduced cortical GABA_A-benzodiazepine receptor binding [162], while ^11C-PBR28 TSPO-PET paradoxically shows lower prefrontal-limbic microglial binding, evidence of neuroimmune suppression rather than activation, which correlates with symptom load [163].

In combined ADHD and PTSD, little PET scan data exists specifically. However, one could extrapolate that such individuals might show markers of dopamine deficit (from ADHD) alongside markers of noradrenergic excess (from PTSD). For instance, a comorbid patient might

simultaneously have elevated DAT (ADHD trait) and elevated locus coeruleus firing (PTSD trait). Interestingly, if ADHD was longstanding and untreated, their chronically low prefrontal dopamine could potentially predispose to stronger NE effects during trauma (since dopamine can buffer stress responses via the mesocortical circuit). PET could in the future be used to see if treating one condition (say giving stimulants for ADHD) ameliorates some neurochemical abnormalities of the other (perhaps reducing PTSD-related depression of dopamine or improving frontal metabolism). At present, though, PET primarily reinforces the notion that ADHD is a disorder of hypoarousal (in attentional circuits) while PTSD is one of hyperarousal (in stress circuits), each with distinct molecular signatures.

Resting-State Connectivity

Spontaneous (resting-state) functional connectivity MRI has provided additional insights by examining how brain networks are organized in ADHD and PTSD when no specific task is being performed. In ADHD, resting-state studies commonly find altered connectivity between large-scale networks, including the default mode network (DMN), frontoparietal (executive) network, and dorsal attention network. As discussed, ADHD patients often show increased coupling of the DMN with task-positive networks and/or reduced internal DMN coherence [136][138][180]. For example, one resting-state study reported that children with ADHD had weaker connectivity within the DMN's core (medial prefrontal–posterior cingulate) and stronger connectivity between DMN regions and the salience network, compared to typically developing peers [136]. This aberrant integration was linked to more variable response times and attentional lapses. Other works have found reduced connectivity in frontal-striatal circuits at rest, suggesting that key nodes like the dorsomedial PFC and caudate are less synchronized in ADHD brains [164]. Notably, stimulant medications tend to increase frontal-striatal connectivity and re-establish a more typical anticorrelation between DMN and task networks at rest, paralleling clinical improvement [135]. In PTSD, resting-state connectivity analyses often reveal disruptions in networks related to self-referential thought and salience. Common findings include decreased connectivity within the DMN, especially between the PCC and hippocampi (as noted above) [139], and aberrant connectivity in the salience network (which includes the anterior insula and dorsal ACC). Some PTSD studies have found hyperconnectivity between the amygdala and insula at rest – reflecting perhaps a constantly primed salience network – along with hypoconnectivity between the prefrontal cortex and amygdala (indicating weak regulatory coupling) [142][140]. Additionally, subnetwork analysis of the DMN shows that PTSD can selectively disrupt the medial temporal lobe subsystem (involved in memory retrieval) more than the core DMN [139]. This may correlate with the fragmented autobiographical memory in PTSD. Interestingly, a subgroup of PTSD patients (those with dissociative subtype)

shows increased connectivity in certain DMN areas (like precuneus) at rest, possibly as a neural correlate of depersonalization, essentially their brain over-engages internal networks as an escape from external reality [143]. When it comes to ADHD/PTSD comorbidity, resting-state patterns might be especially complex. There could be simultaneous ADHD-related network segregation issues (like DMN intruding on task networks) and PTSD-related network hypervigilance (like salience network hyperconnectivity). Hypothetically, a comorbid individual might have an overactive salience network (due to trauma) that frequently triggers inappropriate engagement of DMN or disrupts the executive network (due to ADHD). This could create a "noisy" brain at rest, with poor network differentiation. It is notable that both disorders respond to mindfulness and meditation practice, which is known to recalibrate resting-state networks (often by strengthening connectivity within the executive network and reducing DMN dominance). Preliminary research in PTSD suggests that effective treatments (psychotherapy, SSRIs) can restore more normal connectivity – for example, one study found that after trauma-focused therapy, PTSD patients showed increased resting connectivity between the vmPFC and hippocampus (thought to indicate improved top-down regulation of contextual memory) [142]. Similarly, in ADHD, neurofeedback and cognitive training have been shown to alter resting-state connectivity in frontoparietal circuits, correlating with attention improvements [135]. These findings underscore the plasticity of brain networks and offer hope that even in comorbid conditions, targeted interventions might re-normalize aberrant connectivity patterns.

In summary, across modalities of neuroimaging, whether task fMRI, PET ligand studies, or resting connectivity, adult ADHD consistently emerges as a condition of cortical under-engagement and catecholamine underdrive, while PTSD emerges as a condition of limbic over-engagement and stress-system overdrive. Comorbidity likely produces a mosaic of these features, making neuroimaging both a challenge (interpretation-wise) and a critical tool for disentangling the contributions of each disorder in a given patient. Future studies explicitly focusing on the ADHD–PTSD comorbid population with multimodal imaging will be invaluable to confirm these conjectures and could identify unique biomarkers (for example, a specific connectivity signature or receptor profile) that distinguish comorbid patients from those with only one of the diagnoses. Such knowledge can also guide personalized treatment, e.g., if imaging shows a comorbid patient's PTSD-related network hyperactivity is dominant, therapy might first address that before tackling ADHD-related deficits, or vice versa.

4.11 Genetic Markers and Polymorphisms (DRD4, DAT1, FKBP5, etc.)

ADHD Genetics

ADHD is a highly heritable neurodevelopmental disorder, with twin studies estimating heritability around 70–80% [124]. Genetic research over the past two decades has identified numerous candidate gene polymorphisms and, more recently, common variants through genome-wide association studies (GWAS) that contribute to ADHD risk. Many of the earliest and most replicated genetic markers for ADHD involve genes related to dopamine regulation. For example, a variable number tandem repeat (VNTR) in the DRD4 gene (coding the dopamine D4 receptor) was one of the first associations reported, the 7-repeat allele of the DRD4 exon 3 VNTR is overrepresented in individuals with ADHD [155]. Meta-analyses have confirmed a significant though modest association between the DRD4 7-repeat variant and ADHD (odds ratio ~1.3) [155][165]. This variant leads to a blunted intracellular response to dopamine and has been linked to trait novelty-seeking and impulsivity, fitting the ADHD profile. Another well-studied marker is a VNTR in the 3' untranslated region of the DAT1 (SLC6A3) gene, which encodes the dopamine transporter. Some studies found that the DAT1 10-repeat allele is associated with ADHD, suggesting increased DAT expression and thus lower synaptic dopamine in carriers [165]. However, the DAT1 finding has been less consistent than DRD4; while earlier meta-analyses suggested a small effect, more recent meta-analyses and large samples indicate the DAT1 association may be weak or conditional on factors like ethnicity [165]. Other dopaminergic genes have shown associations as well: DRD5 (a receptor gene) has a promoter microsatellite variant linked to ADHD in multiple studies [155], and DBH (dopamine-beta-hydroxylase, which converts DA to NE) variants have also been implicated. Beyond dopamine, genes in the norepinephrine system (such as the NE transporter SLC6A2 and adrenergic receptors) and serotonin system (e.g. HTR1B) have yielded some positive findings [165]. The broad meta-analytic review of candidate genes by Gizer et al. (2009) concluded that dopamine-related loci (DRD4, DRD5, DAT1) had the most robust support, with lesser evidence for others like 5-HTT and SNAP-25 [165]. In recent years, large GWAS have started to identify specific single-nucleotide polymorphisms (SNPs) across the genome associated with ADHD. The latest ADHD GWAS (2019) discovered the first genome-wide significant loci, at least 12 independent loci, in genes involved in neurodevelopment, synaptic transmission, and particularly glutamatergic neurotransmission [166]. Interestingly, gene-set analyses in that study showed that ADHD risk SNPs were enriched in pathways related to glutamate receptor signaling and neurite outgrowth [166]. This dovetails with evidence of glutamatergic/GABAergic imbalance in ADHD (noted above) and suggests that beyond catecholamine genes, ADHD has a polygenic basis affecting many neural systems. It is important to note that no single "ADHD gene" is determinative – rather, ADHD arises from the combined small effects of thousands of common variants (polygenic risk), a handful of which have been individually identified so far. Still, specific polymorphisms like DRD4 7-repeat and DAT1 10-repeat have provided valuable clues to

neurobiological mechanisms, and they are notable because they also appear in other disorders (e.g., DRD4 7R has been linked to novelty-seeking behaviors across diagnoses).

PTSD Genetics

Unlike ADHD, PTSD is not purely genetically conferred – one must experience trauma to develop PTSD – yet genetics still play an important role in determining who is susceptible. Twin studies estimate PTSD heritability in the range of 30–40% [167], indicating that genetic factors influence the likelihood of developing PTSD after trauma exposure. A landmark finding in PTSD genetics has been polymorphisms in the FKBP5 gene. FKBP5 encodes a protein that regulates the sensitivity of glucocorticoid receptors (GR) to cortisol, essentially part of the feedback loop of the hypothalamic-pituitary-adrenal (HPA) axis. Binder et al. (2008) discovered that several SNPs in FKBP5 interact with childhood trauma to predict adult PTSD risk [168]. In their sample of severely traumatized individuals, carriers of the risk alleles (e.g., the minor alleles of FKBP5 rs1360780 and related SNPs) who had experienced childhood abuse had significantly higher PTSD symptom levels as adults [168]. These FKBP5 risk variants by themselves did not cause PTSD, but under conditions of trauma stress they led to an over-reactive stress hormone response (due to FKBP5 reducing glucocorticoid receptor sensitivity, thus impairing cortisol's negative feedback). This gene–environment interaction has been replicated and extended: those FKBP5 risk alleles are associated with exaggerated and prolonged cortisol responses to trauma and correlate with epigenetic changes (demethylation) in FKBP5 that persist after trauma, effectively "activating" the gene's influence [168][169]. Another notable genetic marker is the serotonin transporter gene (SLC6A4) promoter variant (5-HTTLPR). This variant has long been studied in depression and stress reactivity, and in PTSD it also shows an interaction with environment. Kilpatrick et al. (2007) found that hurricane survivors with the short ("s") allele of 5-HTTLPR and low social support had much higher PTSD rates than long-allele or high-support individuals [170]. The s-allele, associated with lower serotonin transporter expression, is thought to enhance fear conditioning and anxiety after trauma, especially if protective social factors are absent. Similarly, polymorphisms in CRHR1 (corticotropin-releasing hormone receptor 1) and the glucocorticoid receptor gene (NR3C1) have been linked to PTSD risk in interaction with child abuse, reflecting HPA axis genetic influences beyond FKBP5. There is also evidence implicating the dopamine D2 receptor gene (DRD2) in PTSD, as mentioned above [152][153], as well as the COMT gene (which affects dopamine catabolism): COMT's Val158Met polymorphism has been associated with differential fear extinction ability and PTSD risk, with the Met allele (lower COMT activity, higher synaptic dopamine) sometimes linked to better extinction recall and possibly resilience, though findings are mixed. Recent GWAS efforts for PTSD (e.g., by the Psychiatric Genomics Consortium) have begun

to identify significant SNPs as well. A 2019 GWAS of European-ancestry PTSD cases reported genome-wide hits near the CAMKV gene and others, but replication is ongoing and the polygenic architecture of PTSD appears highly complex (with contributions from genes related to neuroticism, depression, and even immune function) [171]. One interesting result is that PTSD genetic risk seems to overlap with that of other psychiatric conditions, including a positive genetic correlation with ADHD found in some studies, meaning some of the same genetic variants might predispose to both ADHD and a propensity to develop PTSD after trauma. This could partly explain the above-average co-occurrence of the disorders.

Polymorphisms and Comorbidity

Certain gene variants might simultaneously influence traits relevant to both ADHD and PTSD. For instance, the DRD2 A1 allele associated with PTSD risk is also known to be associated with impulsivity and substance use – traits often comorbid with ADHD. The DRD4 7-repeat allele, while primarily studied in ADHD, has been linked to greater novelty-seeking which could lead to risky situations and trauma exposure, perhaps indirectly increasing PTSD risk. Conversely, genes that affect stress reactivity (like FKBP5 or 5-HTTLPR) might influence ADHD outcomes: a child with high genetic stress sensitivity might, if exposed to early adversity, have worse ADHD symptom persistence or higher likelihood of developing PTSD after a later trauma. Though research specifically on ADHD–PTSD genetic overlaps is limited, one can speculate that individuals who inherit a combination of neurodevelopmental risk (for ADHD) and stress-response risk (for PTSD) are those most likely to manifest both disorders. In these individuals, one disorder's genetics may amplify the other's expression. For example, an ADHD-related dopamine gene profile could lead to thrill-seeking and hence more trauma, while a PTSD-related gene profile (like an FKBP5 risk allele) could make any trauma experienced by an ADHD individual more psychologically damaging. Understanding each patient's unique genetic makeup may eventually help personalize treatment, e.g., presence of certain polymorphisms might suggest they'll respond better to one medication over another. It's important to note, however, that genes are not destiny for PTSD as trauma exposure is the critical determinant, and for ADHD as well, environment modulates gene expression (epigenetics). Thus, we turn to gene-environment interplay and epigenetics next.

4.12 Genetic Susceptibility and Epigenetics (Gene–Environment Interactions)

Gene–Environment in ADHD

ADHD's etiology involves complex interplay between genetic predispositions and environmental influences, especially those operating early in development. While a child may inherit polygenic risk for ADHD, certain environmental factors can exacerbate or ameliorate the expression of that

risk. For instance, prenatal exposure to toxins (like maternal smoking, alcohol, or high stress during pregnancy) has been linked to increased ADHD symptoms in offspring, particularly in genetically susceptible children [173]. Meta-analyses indicate that maternal smoking during pregnancy roughly doubles the risk of ADHD in the child [172]. This effect may be partially genetic (mothers who smoke might share impulsivity genetics with the child), but there is evidence of a true environmental impact of nicotine on fetal brain development. Such exposures can cause epigenetic modifications in the fetus. Recent research has identified differences in DNA methylation at birth associated with later ADHD outcomes [169]. For example, Neumann et al. conducted a prospective meta-analysis of DNA methylation from cord blood and found certain methylation marks in genes like DRD4 and VIPR2 that correlated with ADHD symptom trajectories through childhood [174]. Epigenetic changes in dopamine-related genes (DRD4, DRD5, DAT1) have been observed in some ADHD samples [177], though not consistently across all studies. Another study [175] found methylation changes in neurotrophic and neural adhesion genes in children with ADHD, hinting that in utero or early-life environment can leave lasting "marks" on the genome that influence neurodevelopment. Stress and psychosocial adversity in childhood (e.g. abuse, neglect, severe poverty) also interact with ADHD genetics. Children with certain genotypes may be more sensitive to parenting quality, the "differential susceptibility" model. For instance, a child with the DRD4 7R allele might show especially high ADHD symptoms in a chaotic, unsupportive home, but do quite well in a structured, nurturing environment, relative to other children [173]. In other words, the same "risk" allele could magnify bad environments or magnify good environments. Such gene–environment interactions have been reported; one study found that the effect of childhood trauma on adult ADHD persistence was stronger in individuals with certain serotonin transporter genotypes [173]. Epigenetically, early trauma in ADHD youth has been linked to methylation differences in stress-related genes. Methylation of the glucocorticoid receptor gene (NR3C1) in childhood has been associated with both ADHD symptoms and emotional dysregulation, suggesting a pathway by which early stress might epigenetically program HPA-axis dysregulation in those predisposed to ADHD [173]. Overall, while genetic makeup sets the stage (conferring general susceptibility to attentional problems), environmental factors, ranging from prenatal insults to parenting and psychosocial stress, help determine the severity and course of ADHD. These environmental factors can literally alter gene expression via epigenetic mechanisms, thereby influencing neural development. Importantly, positive environments (consistent discipline, cognitive enrichment, physical exercise) might offset some genetic risk by promoting better self-regulation and perhaps even normalizing some epigenetic marks (though human evidence of "reversal" of methylation in ADHD is still emerging).

Gene–Environment in PTSD

PTSD is prototypically gene–environment interaction in action: no PTSD without trauma, but given the same trauma, some people (due to genetics and other factors) develop PTSD and others do not. We've already seen a clear example with FKBP5 – risk allele carriers only had worse PTSD if they also had childhood abuse, illustrating a classic GxE interaction [168]. Beyond FKBP5, numerous studies have documented that the impact of traumatic exposure on later PTSD is moderated by genotype. Another well-known example is the 5-HTTLPR finding by Kilpatrick et al. [170]: after a hurricane, individuals with the *ss* genotype and low support had PTSD rates ~4.5 times higher than *l*-allele individuals with high support. Thus, the serotonin transporter gene and social environment interacted to determine outcome. Epigenetics provides a mechanistic layer to these interactions. Traumatic stress can induce long-lasting changes in gene expression regulation. For instance, traumatic events have been associated with changes in DNA methylation of the NR3C1 gene (which encodes the glucocorticoid receptor). Holocaust survivors with PTSD and even their offspring have shown increased methylation in the NR3C1 promoter region, which is thought to reduce glucocorticoid receptor expression and thereby interfere with stress hormone negative feedback [176]. This represents an epigenetic mark potentially passed to the next generation (although the interpretation of intergenerational epigenetic inheritance in humans is complex). In the case of FKBP5, trauma exposure (especially childhood trauma) in carriers of risk SNPs leads to demethylation of certain FKBP5 loci in intron 7, which in turn results in higher FKBP5 expression and a more prolonged cortisol spike after stress [169]. This is an epigenetic switch that essentially "locks in" a PTSD-vulnerable phenotype at the molecular level after trauma. Epigenome-wide studies of PTSD have identified differential methylation in genes related to immune function, brain signaling, and development in those with PTSD vs. resilient trauma survivors [177]. For example, Mehta et al. (2013) found that PTSD was associated with distinct methylation profiles in immune and HPA-axis genes, supporting the idea that trauma can leave a broad epigenetic signature [177]. Importantly, not all environmental influences on PTSD are negative – protective factors (like strong social support, as noted, or particular coping skills) can mitigate PTSD risk even in genetically vulnerable individuals [170]. The presence of supportive relationships and early intervention after trauma can biologically attenuate stress responses (for example, by reducing circulating stress hormone levels), which might prevent some of the deleterious epigenetic changes or even promote beneficial ones (like upregulation of neurotrophic factors). One fascinating area of study is whether psychotherapy or pharmacotherapy for PTSD can induce epigenetic changes that correlate with recovery. Preliminary evidence suggests therapy might reverse some trauma-induced methylation changes; for instance, some studies showed that effective psychotherapy was associated with

increased methylation (silencing) of FKBP5 in those risk allele carriers, essentially undoing the prior demethylation to an extent [118]. Though still early, this raises hope that epigenetic marks are malleable rather than permanently etched.

In context of ADHD–PTSD comorbidity, gene–environment interplay could be quite significant. Children with ADHD often experience academic failure, social rejection, and sometimes family conflict due to their symptoms, which are environmental stressors that could predispose them to PTSD if a significant trauma occurs later. Additionally, ADHD impulsivity might increase the likelihood of encountering traumatic events (e.g., accidents, fights), thus representing a gene–behavior–environment cascade. From the epigenetic perspective, an individual with ADHD who faces chronic stress (like bullying or abuse) in childhood may develop methylation changes in stress-related genes; then if they later endure a major trauma, those changes (e.g., an already sensitized HPA axis via NR3C1 methylation) could facilitate PTSD development. Conversely, effective support and intervention for an ADHD child (providing structure, therapy, etc.) might reduce not only immediate impairment but also buffer them against traumatic stress, both psychologically and perhaps biologically (by maintaining healthier stress-response gene regulation).

In summary, both ADHD and PTSD exemplify how genetic susceptibility interacts with environmental exposures to shape outcomes. ADHD gene effects can be amplified by negative environments or dampened by positive ones, and PTSD requires trauma but genetics influence sensitivity to trauma. Epigenetic modifications serve as a molecular record of these gene–environment interactions, some of which have been identified for each disorder (e.g., methylation in DRD4 for ADHD, FKBP5 for PTSD). Recognizing these interactions underscores the importance of early interventions – reducing environmental risk factors (like childhood abuse, prenatal toxin exposure) could significantly lower the incidence of both ADHD and PTSD even among genetically predisposed individuals. It also highlights potential for novel treatments: for example, epigenetic therapies (drugs that modify DNA methylation or histone states) are being explored in PTSD to 'reset' pathological gene expression, and similar logic might one day apply to ADHD. Ultimately, the biology of ADHD and PTSD cannot be fully understood without accounting for how genes and environment dance together throughout the lifespan.

4.13 Neuroplasticity and Reversibility

One encouraging aspect emerging from research is that the neurobiological changes in ADHD and PTSD are not static, they can evolve over time and, in some cases, partially normalize with effective treatment or maturation. Both disorders exhibit a degree of neuroplasticity, whereby

interventions or natural developmental processes lead to measurable changes in brain structure and function.

ADHD Neuroplasticity

Longitudinal studies of individuals with ADHD show that many of the structural brain differences lessen with age. By adulthood, some patients who had pronounced cortical delays in childhood catch up to normal ranges. Shaw et al. famously demonstrated a approximately 2-3 year delay in cortical maturation (especially in frontal regions) in ADHD youth, but by late adolescence many reached similar cortical thickness as peers [21]. This aligns with clinical observation that about half of children with ADHD no longer meet full criteria by adulthood – their brains likely developed compensatory changes. Neuroimaging evidence supports this: a study found that adults with remitted ADHD had more normalized ACC volumes and frontal thickness compared to adults whose ADHD persisted [132]. In fact, the ENIGMA meta-analysis noted that the case–control differences in subcortical volumes were non-significant in adults (while significant in children), suggesting developmental catch-up or plastic changes in those brain areas [118]. Treatment, particularly with stimulant medication, may facilitate some of these normalizing changes. There is evidence that stimulant treatment may "normalize" certain brain structures and activity in ADHD over the long term [178]. For example, an earlier meta-analysis reported that medicated ADHD patients had less pronounced gray matter volume deficits than never-medicated patients [176]. Seidman et al. found that stimulant-medicated adults had ACC volumes closer to control means than unmedicated adults with ADHD [117]. Another longitudinal study using MRI indicated that childhood stimulant use was associated with slightly larger basal ganglia volumes in adolescence, stimulants might mitigate the reductions in caudate/putamen volume seen in ADHD [179]. Functionally, stimulants have an acute normalizing effect: they increase frontal activation and reduce hyperconnectivity of the DMN during cognitive tasks in ADHD patients, often making their brain activation patterns more closely resemble those of controls [135]. Over months to years of treatment, these acute effects can translate into sustained network changes.

Non-pharmacological interventions can also induce neuroplastic changes. Cognitive behavioral therapy for adult ADHD has been associated with enhanced activation in prefrontal regions during executive tasks (as patients apply learned strategies), and neurofeedback training has demonstrated increases in beta-band power (associated with focused attention) and changes in functional network connectivity on EEG/fMRI [135]. These findings underscore that the adult ADHD brain is capable of reorganization and improvement. While not all brain alterations in ADHD fully normalize, some differences persist even in well-managed cases, the degree of improvement is substantial in many individuals, reflecting both spontaneous developmental plasticity and treatment-driven plasticity.

PTSD Neuroplasticity

PTSD was once conceptualized as a permanent "scar" on the brain, but we now know that many of its neural effects can be at least partially reversed with successful therapy or pharmacotherapy. Perhaps the most striking example is the hippocampus, which shows remarkable plasticity in PTSD. Early studies raised concern by showing smaller hippocampi in PTSD, but later work demonstrated that this atrophy is not necessarily irreversible. Vermetten et al. conducted a landmark study where adult PTSD patients underwent open-label treatment with paroxetine (an SSRI) for 9–12 months [178]. They found a roughly 5% increase in hippocampal volume on MRI following treatment, accompanied by improvements in verbal memory [178]. This was the first evidence in humans that hippocampal shrinkage in PTSD could be mitigated. Subsequent studies have corroborated this effect: chronic antidepressant treatment (SSRIs) and certain psychotherapies have been associated with hippocampal volume increases or stabilization in PTSD patients [137][133]. For instance, a randomized trial of prolonged exposure therapy showed that responders had an increase in left hippocampal gray matter density compared to non-responders [132]. Such changes are likely mediated by restoration of normal cortisol levels and increased BDNF (brain-derived neurotrophic factor) expression promoting neurogenesis in the dentate gyrus – processes that SSRIs can facilitate. Beyond the hippocampus, functional neuroimaging confirms that therapy can normalize hyperactive and hypoactive regions in PTSD. After successful trauma-focused psychotherapy, PTSD patients tend to show reduced amygdala responses to trauma reminders and increased activation of vmPFC/ACC during emotional regulation tasks [121][133]. Essentially, therapy strengthens the prefrontal inhibitory pathways and calms the limbic fear center – exactly the inverse of the PTSD baseline pattern. A systematic review by Kennis et al. found that across studies, effective PTSD treatments consistently resulted in greater recruitment of frontal regions (like dorsal ACC and lateral PFC) and decreased insula/amygdala activation during post-treatment scans [133]. Even at the connectivity level, PTSD is plastic: one resting-state fMRI study reported that post-traumatic stress disorder patients who underwent mindfulness-based stress reduction showed enhanced functional connectivity between the anterior insula and prefrontal cortex after the intervention, correlating with reduced hyperarousal symptoms [181]. Neurofeedback is another promising tool, one study using real-time fMRI neurofeedback to train positive emotion regulation reported both symptom improvements and a significant increase in hippocampal volume in the neurofeedback group versus controls [182]. This aligns with the notion that directed mental training can induce structural brain changes (via neurogenesis or dendritic remodeling in targeted regions). On a molecular level, treatment can also shift epigenetic marks related to PTSD. For example, psychotherapy has been associated with increased methylation of the FKBP5 gene in some

responders [183], suggesting a "resetting" of HPA-axis regulation toward normal. Similarly, exercise and mind–body interventions (yoga, meditation) have been shown to lower inflammatory markers [184] and might influence gene expression profiles tied to stress and plasticity (though more research is needed here).

Implications for Comorbidity

The neuroplastic potential in both disorders offers hope that even if a patient suffers from both ADHD and PTSD, appropriate treatment of each condition could lead to meaningful brain changes and improved outcomes. For instance, treating the PTSD in an ADHD/PTSD patient may reverse some stress-induced hippocampal or ACC changes, potentially making it easier for them to benefit from ADHD interventions (since their memory and emotional stability improve). Conversely, treating ADHD (with stimulant medication or cognitive training) in a patient might enhance their frontal lobe functioning and organizational abilities, which could bolster their engagement in PTSD psychotherapy and their capacity to regulate triggers. There is some case evidence that stimulant treatment in PTSD patients (especially those with comorbid ADHD) can reduce PTSD symptoms like avoidance and numbing, presumably by increasing dopaminergic tone and improving prefrontal oversight of emotion [1]. Likewise, as mentioned, alpha-adrenergic blockers used for PTSD might concurrently help an ADHD patient by improving sleep and reducing hyperarousal that can mimic ADHD restlessness. The brain's interconnected networks mean that positive changes in one domain often carry over to another; for example, increasing hippocampal volume and function (through PTSD treatment) not only aids context processing for fear extinction but also could help general learning and memory, potentially benefiting ADHD-related cognitive issues. It's also worth noting developmental timing: early effective treatment of ADHD in children might reduce exposure to traumatic experiences (e.g., by decreasing impulsive risk-taking or improving school environments), thus indirectly preventing PTSD. And early intervention in traumatized youth with ADHD could prevent compounding of attentional problems by traumatic stress. Both disorders show sensitive periods where intervention yields big gains – childhood/adolescence for ADHD neurodevelopment, and the period soon after trauma for PTSD (to prevent consolidation of pathological fear memories). Capitalizing on neuroplasticity during these windows is crucial.

Finally, beyond treatment-induced plasticity, there is evidence of natural recovery in substantial subsets of patients: many individuals with ADHD find their symptoms diminish in adulthood as they develop coping strategies and their brain matures [132]; likewise, a significant number of people with PTSD (especially those with milder symptoms or strong support) experience remission within a few years post-trauma, possibly due to the brain's innate resilience and relearning

(extinction) of safety cues. These spontaneous improvements further illustrate the brain's capacity to rewire and heal.

In conclusion, while adult ADHD and PTSD are associated with substantial neurobiological changes, these changes are by no means fixed. Appropriate interventions can lead to partial normalization of brain structure/function, leveraging neuroplasticity to improve symptoms. This reinforces a hopeful message: comorbid ADHD and PTSD patients, despite having two challenging conditions, have brains that are capable of adaptation and improvement. Multimodal treatment addressing both conditions (e.g. a combination of medication for ADHD, psychotherapy for PTSD, stress-reduction techniques, and cognitive rehabilitation) can produce synergistic benefits, essentially "rewiring" dysfunctional circuits step by step. The ongoing challenge for research is to optimize these interventions and understand the neuroplastic changes they induce, thereby continually refining our ability to promote recovery in the brain.

4.14 Treatment of Adult ADHD with Comorbid PTSD

4.15 Pharmacological Interventions

ADHD Treatment

Pharmacotherapy is a cornerstone for adult ADHD management. Stimulant medications (e.g. amphetamine-based stimulants and methylphenidate) consistently show robust efficacy in reducing core ADHD symptoms in adults [186] Network meta-analyses confirm that amphetamine derivatives (e.g. lisdexamfetamine) are often the most effective first-line medications for adult ADHD, with methylphenidate also yielding substantial symptom reduction [187]. Reported effect sizes for stimulant treatment in adults are moderate-to-large, with significant improvements in attention and impulsivity compared to placebo [186]. Non-stimulant options are also important: the selective norepinephrine reuptake inhibitor atomoxetine is FDA-approved for adult ADHD and produces moderate symptom improvements (particularly inattention) relative to placebo [188]. Meta-analyses of 13 randomized trials indicate atomoxetine yields a standardized mean difference around 0.4-0.5 versus placebo on adult ADHD rating scales [188].

Other non-stimulants such as extended-release guanfacine have shown efficacy in some trials and are used as second-line agents [187]. Overall, pharmacological treatment is effective for adult ADHD, significantly reducing core symptoms in the majority of patients [187].

PTSD Treatment

Pharmacotherapy for PTSD in adults often centers on antidepressants. Selective serotonin reuptake inhibitors (SSRIs) are considered first-line medications for PTSD and have the strongest evidence

base [189]. A high-quality meta-analysis of 66 RCTs found that SSRIs significantly improve PTSD symptom severity compared to placebo (e.g. response in ~58% on SSRIs vs 35% on placebo) [189]. Serotonin-norepinephrine reuptake inhibitors (SNRIs) have also demonstrated efficacy: for example, venlafaxine extended-release outperformed placebo in reducing PTSD symptoms [190] with possible higher efficacy in acute phase remission [191] with further studies needed to show proof. Other antidepressants can be useful in certain cases, mirtazapine (a noradrenergic and specific serotonergic antidepressant) and the tricyclic antidepressant amitriptyline each showed benefit in small trials, though evidence quality was low [189]. In addition, prazosin, an alpha-1 adrenergic blocker, is commonly used off-label to target PTSD-related nightmares and sleep disturbance. A systematic review and meta-analysis found prazosin leads to substantial reduction in nightmare frequency (pooled effect size ~1.1) [192], although its impact on overall PTSD symptoms was not significantly different from placebo [192]. Taken together, antidepressant pharmacotherapy yields a modest overall reduction in PTSD symptom severity [193][189], and prazosin can be a valuable adjunct for sleep-related symptoms. It should be noted that pharmacological response in PTSD is often incomplete. Many patients have residual symptoms even with optimized antidepressant treatment.

Augmentation strategies have been explored for SSRI-resistant cases, for example, atypical antipsychotics have been tried to target hyperarousal, but evidence is mixed. A large placebo-controlled trial in military-related PTSD found no added benefit of adjunctive risperidone over placebo in patients not responding to SSRIs [194], leading to caution against routine antipsychotic augmentation for PTSD [195]. Other agents under study include anti-adrenergics (propranolol) and anticonvulsants (topiramate), but findings are inconsistent, and these are not first-line [196].

Comorbid ADHD/PTSD Management

Barreto et al. (2022) described a patient with adult ADHD and chronic PTSD whose PTSD symptoms (including concentration and energy) improved concurrent with titration of lisdexamfetamine, allowing better engagement in therapy [114]. Another recent case report demonstrated that atomoxetine not only improved attention in an ADHD/PTSD patient but was associated with reduced hypervigilance, anxiety and even chronic pain symptoms over time [197]. These anecdotal findings align with theoretical expectations: by reducing distractibility and impulsiveness, ADHD medications might indirectly help patients manage trauma-related stresses (e.g. improving concentration during therapy sessions or enhancing organization in daily life) [198]. However, caution is warranted given the potential for stimulants to exacerbate anxiety, insomnia or hyperarousal in PTSD patients [199][200]. Clinicians therefore often start with lower doses and closely monitor comorbid patients for any worsening of PTSD symptoms such as jitteriness or

insomnia. In practice, when pharmacotherapy is indicated for ADHD/PTSD, a reasonable strategy is to first initiate an ADHD medication (stimulant or atomoxetine) to address attentional deficits, while concurrently treating PTSD with an SSRI if not already on one [198]. This combined pharmacotherapeutic approach, e.g. an SSRI for core PTSD symptoms and a stimulant or non-stimulant for ADHD, is frequently employed in clinical settings, though formal trial data on combination regimens are lacking. Importantly, any pharmacologic plan should be individualized: factors such as predominant symptom burden, patient tolerance, and potential drug interactions (for example, watching for blood pressure elevation [201] when combining stimulants with PTSD-related noradrenergic hyperactivation) must guide medication selection. Additionally, it should be emphasized that starting PTSD medication early is important because antidepressants often take weeks to exert full effect.

Early and effective treatment of ADHD in trauma-exposed individuals might even be preventative – studies suggest untreated ADHD is associated with heightened risk of developing PTSD following trauma [202][203], so timely pharmacological intervention for ADHD may reduce that risk. In summary, medications are valuable tools in the integrated treatment of comorbid adult ADHD and PTSD, but they should be used in concert with psychotherapy (not as a standalone) to achieve optimal outcomes.

4.16 Psychotherapeutic Approaches

ADHD-Focused Psychotherapy: Although medication is primary in adult ADHD, psychosocial interventions play a critical role, particularly in improving functional outcomes and coping skills. Cognitive-behavioral therapy (CBT) tailored for adult ADHD has demonstrated some efficacy in several trials and reviews analyzed in a Cochrane systematic review [204]. The review found “low-quality evidence that cognitive-behavioral-based treatments may be beneficial for treating adults with ADHD in the short term” but “Reductions in core symptoms of ADHD were fairly consistent…”.

Beyond CBT, other psychotherapeutic approaches for adult ADHD include dialectical behavior therapy (DBT) skills for emotional dysregulation, mindfulness-based interventions, and ADHD coaching. Mindfulness training in particular has shown promise [205] in improving attention regulation and executive functioning in adults with ADHD [206]. In contrast, psychodynamic psychotherapy shows almost no empirical support. A systematic review by Conway [207] found that all identified work consisted of case studies, clinical vignettes, and theoretical discussions, almost entirely in children. Similarly, a recent scoping review of adult ADHD treatments concluded

that very few studies have examined psychoanalytic or psychodynamic interventions; what little exists is limited to a small group program and single-case or observational reports [208].

In sum, therapy for adult ADHD focuses on building compensatory skills and addressing secondary issues, rather than "curing" core symptoms. Such interventions are especially pertinent for comorbid cases, as they can lay the groundwork for patients to engage more effectively in PTSD-focused treatments.

Table 4: List of psychotherapies for ADHD

Therapy	Effect Size (SMD)	Sensitivity (%Responders)	Evidence quality	Typical Treatment Protocol
Cognitive-Behavioral Therapy (CBT	0.76 (large vs waitlist) [268]	56.0 (Res>13%) [269]	Moderate (meta-analysis of ~9–14 RCTs)[204]	8-12 weekly sessions[204]
Dialectical Behavior Therapy (DBT)	≈0.64[270]		2024 meta-analysis (7 RCTs)[270]	14 weekly 120 min group sessions.[270]
Mindfulness-Based Interventions (MBI/MBCT)	0.5 (moderate) [271]		2023 meta-analysis (7 RCTs)[282]	8 weekly 2.5-h group sessions plus one half-day silent retreat; daily home mindfulness practice (~30 min) assigned[272].
Metacognitive Therapy (MCT)			Moderate (1 RCT, Safren et al. 2010, n≈86)[274]	12 weekly 2-h group sessions focusing on metacognitive strategies (time-management, planning, organization)[273]
Acceptance & Commitment Therapy (ACT)			Very low (scoping review of few trials)[275]	3-26 weekly sessions[275] depending on program
Psychoeducation (group/webinar)			Very low (scoping review; no effect estimates)[276]	~4–6 weekly sessions covering ADHD education, medications, lifestyle, and coping strategies [277]
ADHD-Focused Coaching			Very low (small studies/case series)[278]	8–12 weeks of 45–60 min individual sessions, with between-session check-ins; goal setting & accountability[279].
Computerized Cognitive Training	0.24 (small)[280]		Moderate, meta-analysis (adult subset)[281]	25 computer sessions (30–45 min each) over 5 weeks (5 sessions/week) targeting working mem[281].

PTSD-Focused Psychotherapy: Trauma-focused psychotherapy is the cornerstone of PTSD treatment and is strongly recommended as first-line by clinical practice guidelines [196] [209]. One of the most extensively studied is Prolonged Exposure (PE) therapy, which involves gradual imaginal and in vivo exposure to trauma memories and cues to extinguish fear responses. PE has demonstrated large effect sizes in reducing PTSD symptom severity. A meta-analysis found that the average patient receiving PE fared better than ~86% of patients in control conditions with respect to PTSD symptoms at end of treatment [210], with another showing high strength of evidence for improving symptoms [211].

Processing Therapy (CPT) is another trauma-focused CBT modality, emphasizing cognitive restructuring of trauma-related beliefs (e.g. addressing self-blame, guilt, mistrust). Like PE, CPT has strong empirical support: in randomized trials, CPT leads to substantial PTSD symptom reduction and loss of diagnosis in a significant proportion of patients, often comparable to PE outcomes [212].

Eye Movement Desensitization and Reprocessing (EMDR) is a further well-established approach, which pairs recall of trauma memories with bilateral stimulation (such as guided eye movements). EMDR has been shown to be as effective as traditional exposure therapy in head-to-head comparisons [213][214].

Other evidence-based psychotherapies include Narrative Exposure Therapy, Brief Eclectic Psychotherapy, and Interpersonal Psychotherapy for PTSD, among others, each with supportive data in specific populations [215]. For example, Paintain and Cassidy (2018) found that although CBT (with exposure) consistently yields larger symptom reductions, psychodynamic psychotherapy can also produce meaningful improvement in PTSD severity [216]. More recently, an open clinical trial of trauma-focused psychodynamic psychotherapy (TFPP) delivered to LGBTQ patients with PTSD showed that after 12 weeks of twice-weekly therapy, 71% of patients met criteria for clinical response (half achieved remission) and mean clinician-rated PTSD scores (CAPS-5) dropped by ~22 points (effect size d≈1.98) [217].

Table 5: List of psychotherapies for PTSD

Therapy	Efficacy (Effect Size / Remission)	Specificity	Generalizability (Sensitivity)	Methodology (Sessions/Length)
Prolonged Exposure (PE)	Large PTSD reduction (Hedges' $g \approx 0.7$ vs waitlist)[256]; generally *>50%* of completers no longer meet PTSD criteria (remission)[212].	Trauma-focused (imaginal & in vivo exposure)	Effective across traumas and cultures[209]; positive outcomes in civilian and veteran samples[256].	Typically 8–15 sessions, 60–90 min each (~2–3 months total) [209].

Table 5: List of psychotherapies for PTSD "continued"

Cognitive Processing Therapy (CPT)	Very large effect (g≈1.2 vs no treatment)[257]; about *51%* more patients remit vs control[209].	Trauma-focused (cognitive restructuring of trauma beliefs)	Effective across ages, genders, trauma types[257][258].	~12 sessions, 60–90 min each (usually ~12 weeks total)[259].
EMDR	Large effect (g≈0.9 vs control) [260]	Trauma-focused (bilateral eye movements during trauma recall)	Studied in assault, combat, accident survivors; consistent efficacy[261].	~6–12 sessions, 60–90 min each (~3 months)[262].
Narrative Exposure Therapy (NET)	Moderate effect (g≈0.6 vs control)[263]; ~2.2× higher remission rate vs control[263].	Trauma-focused (exposure via life-story narration)	Primarily tested in refugees/conflict survivors [263].	~4–10 sessions, ~75–90 min each (mean ~6–7 sessions; ~10–12 hours total)[264].
Written Exposure Therapy (WET)	Very large improvement vs waitlist (limited data: g≈1.5)[256]; noninferior to CPT in RCT[265].	Trauma-focused (writing detailed trauma narrative)	Demonstrated efficacy in veteran and civilian samples (comparable outcomes to longer therapies)[265].	5 sessions (1×60 min, then 4×40 min) (~5 weeks total)[265].
Cognitive Therapy (Ehlers/Clark)	Very large improvement in RCTs: e.g. 77% recovered (vs 43% control); only ~11% PTSD (vs ~55–60% in controls) at follow-up[266].	Trauma-focused CBT (addresses trauma appraisals and memory)	Shown highly effective for recent-onset PTSD (e.g. accident, assault) (intensive and weekly formats both effective)[266].	Typically ~10–12 sessions, 60–90 min each (~3 months) (intensive variants of ~7 days also studied)[266].
Stress Inoculation Training (SIT)	Moderate PTSD reduction (vs no treatment) [267]	Non–trauma-focused CBT (anxiety management skills)	Effective in assault survivors; also used in various PTSD groups, but generally less potent than trauma-focused therapies[267].	~9 sessions, 60–90 min each (twice-weekly) (~4–5 weeks total)[267].

Across modalities, trauma-focused treatments achieve clinically meaningful change in a majority of patients, with roughly two-thirds not meeting PTSD criteria after a full course of therapy and half of all patients who initiate trauma-focused therapy achieving recovery [212]. Importantly, these therapies not only reduce PTSD symptoms but often yield secondary benefits in depression, anxiety, and functioning.

4.17 Environmental Adversities

Peer rejection

Teachers and parents rate children with ADHD about one standard deviation below peers on social skills measures [218], indicating pervasive social-skill deficits. These deficits include difficulty reading social cues, inhibiting inappropriate comments, and modulating emotional responses. The combination of excessive or disruptive behaviors (e.g. interrupting, intruding) and lack of prosocial skills (e.g. taking turns) rapidly elicits negative reactions from peers [219].

Peer problems in ADHD emerge early and tend to persist. By elementary school, depending on the study, up to 80% of children with ADHD are classified as peer-rejected, vastly higher than the ~10-15% rejection rates in non-ADHD samples [220].

Persistent peer rejection contributes to a range of adverse outcomes for individuals with ADHD. Rejection and isolation can directly impact emotional health. Several studies indicate that peer problems mediate the link between childhood ADHD and later internalizing disorders: social failure and negative peer appraisals are proposed contributors to the elevated depression and anxiety seen in ADHD populations [221][222]. Mrug et al. (2012) followed MTA participants into adolescence and reported that greater peer rejection in childhood robustly predicted later externalizing outcomes: rejected children had higher rates of cigarette smoking and delinquency, as well as increased anxiety and overall impairment by mid-adolescence [223].

An MTA trial noted that even high-quality medication and behavior therapy failed to improve sociometric status [224]. These findings suggest that symptom reduction alone is insufficient to change peer perceptions. By contrast, interventions that actively involve peers show promise. Mikami et al. (2013) demonstrated that training classmates to be more inclusive significantly increased ADHD children's peer preference and number of reciprocated friendships relative to standard behavioral management [225]. Systematic reviews echo this: Cordier et al. (2018) found that interventions incorporating typically developing peers (e.g. peer tutoring, buddy systems) led to significant pre-post gains in social skills for ADHD children, whereas gains were not evident in control conditions [226].

Familial adversity

Jendreizik et al. (2022) emphasizes that many environmental risks for ADHD onset act prenatally or in early infancy (maternal smoking, toxins, severe deprivation, etc.), whereas adversities emerging later in childhood tend to influence the severity of ADHD symptoms rather than initial case status [227]. Claussen et al.'s recent meta-analysis found that numerous family stressors significantly predicted subsequent ADHD symptom levels. These included child-directed maltreatment (general neglect or abuse), harsh and intrusive parenting, and indicators of family instability such as parental divorce, single-parent status, and even parental incarceration [228].

Notably, maternal ADHD carried especially high risk: mothers with ADHD reported greater hostility and family discord than non-ADHD mothers, whereas paternal ADHD had a subtler pattern of effects on family relations [229]. This suggests that parental ADHD may exacerbate child ADHD severity through both genetic inheritance and by interfering with effective parenting.

4.18 Emerging and Integrative Treatments

Growing research has explored novel treatments that might simultaneously or sequentially benefit ADHD and PTSD or augment standard care. One area of interest is mindfulness and meditation-based therapies, which are considered integrative approaches affecting mind-body regulation. Mindfulness-Based Cognitive Therapy and related programs have shown efficacy in reducing ADHD symptoms by improving sustained attention and executive control [230]. A study on active-duty military personnel with both PTSD and ADHD who underwent an 8-week mindfulness training (either in-person or virtual) found meaningful reductions in post-traumatic stress symptoms (particularly in the in-person group) and significant improvements in self-reported attentional symptoms [231]. Although the PTSD symptom reductions did not reach statistical significance in that small trial, the clinical relevance was evident, suggesting mindfulness training can be a valuable adjunct for comorbid patients but needs further study.

Another emerging intervention that bridges neuropsychological and somatic domains is neurofeedback. Neurofeedback (NFB) involves real-time EEG-based feedback to train patients to self-regulate brain activity [232]. This modality has been studied in ADHD, with meta-analyses indicating small-to-moderate improvements, however the analyzed studies have been mostly conducted on children or adolescents and also not with a co-diagnosis of PTSD [233]. Notably, NFB is garnering evidence in PTSD: a recent systematic review and meta-analysis of 10 studies (7 RCTs) found that neurofeedback had a moderate beneficial effect on PTSD symptoms, with a significant pooled reduction in severity (standardized mean difference ~–1.76) and a higher remission rate (79% in NFB vs 24% in controls) [234]. These seem to be promising results, albeit from preliminary and heterogeneous trials. Given its noninvasive nature, NFB is an appealing integrative tool; however, further research is needed to confirm long-term efficacy (especially for adults) and to determine protocols that address both disorders simultaneously.

Other techniques include repetitive transcranial magnetic stimulation (rTMS). Depending on the targeted brain area effect varies, with one clinical trial finding the right PFC as a target for inattention in ADHD [235]. The meta-analysis by Chen and colleagues (2023) supports the effectiveness of rTMS [235]. In PTSD, TMS also seems to have beneficial effects [237] [238].

Interestingly, transcranial direct current stimulation (tDCS) showed the greatest effect on the left dorsolateral prefrontal cortex, mainly increasing inhibitory control. Xie et all (2024) found in their analysis immediate effects for PTSD treatment, with a moderate effect size up to a month [239].

Other notable novel therapies include MDMA-assisted psychotherapy for PTSD. In a landmark phase 3 trial, MDMA-assisted therapy for chronic PTSD produced significantly greater symptom

reduction and functional improvement than psychotherapy with placebo, with 67% of the MDMA group no longer meeting PTSD criteria at study end versus 32% of placebo group [52]. Importantly, this approach was effective even in patients with multiple comorbidities, and it was well-tolerated under controlled conditions. Though MDMA is not a treatment for ADHD per se, its ability to increase dopamine raises interesting questions about whether an MDMA-facilitated session might also transiently improve attention or motivation.

4.19 Treatment Outcomes and Prognoses

Treating both ADHD and PTSD in adults can significantly improve long-term outcomes, though prognosis varies with severity, treatment adherence, and individual factors. It is well documented that each condition alone can adversely impact life course, and their co-occurrence often compounds impairment [1].

ADHD Outcomes

Adult ADHD is a chronic neurodevelopmental disorder; complete remission is relatively uncommon, but symptom reductions and functional gains are achievable with sustained treatment. Long-term studies indicate that a majority of children experience full remission of ADHD, one review suggesting an average 43% of childhood ADHD cases persist in adulthood, while the rest continue to have at least some symptoms, both often accompanied by other psychological comorbidities [240]. The systematic review by Erskine et al demonstrates worse academic achievements and employment status, while criminality and other disorders are higher. Adherence to pharmacological treatment often produces lasting improvements in attention and impulse control that translate into better educational and occupational functioning [241], with Lopez at all finding that additional CBT produced even better result [204].

Interestingly for this review, medicated male adults had far fever transport accidents [243], which possibly could lead to PTSD. Meaning, early diagnosis and treatment of ADHD might decrease rates of PTSD in an already vulnerable population by raising attention and decreasing impulsivity in a patient's daily life. A possible study could look into accident rates (work, transportation, at home) of diagnosed ADHD patients, followed by reported PTSD and compare that to a control group or general population.

PTSD Outcomes

The natural course of PTSD can be chronic if left untreated with one review noting a median 14-year remission time [244], but evidence-based psychotherapy (and to a lesser extent pharmacotherapy) can induce remission or significant improvement in a large proportion of

patients, as mentioned in the sections on therapy and pharmacology. Notably, the trigger type for PTSD plays a role in remission percentage (60% for natural disaster to 31.4% for physical disease) [245] and remission does not equal a cure, only that PTSD criteria are not fully met anymore. A study of war veterans by Levi et al. found that only 10.7% showed remission in all three PTSD clusters after treatment [246]. Caution is advised especially for comorbid ADHD patients, as PTSD might be seen as fully treated while one cluster might still be "active", feeding ADHD symptoms.

Prognosis for Comorbid ADHD and PTSD

When ADHD and PTSD are both present, the clinical picture is more complex [1] and the path to recovery can be lengthier, as multiple issues are tackled initially. There is evidence that treating ADHD can enhance factors protecting against PTSD: one longitudinal study found that soldiers with better ADHD medication adherence had lower subsequent PTSD symptoms [112], as well as the above-mentioned lower accident rates.

Long-term outcome studies specifically on the ADHD/PTSD population are still needed, but one can extrapolate from related research. In general, comorbidity tends to increase the risk of relapses or recurrence. A patient whose PTSD went into remission after therapy could later encounter severe stress (e.g. a new trauma or loss) and have a resurgence of PTSD symptoms; if that patient also has ADHD, the resurgence might be exacerbated by any lapse in ADHD treatment or skills (for instance, if disorganization leads to stopping medications or missing follow-ups).

4.20 Gender and Age Differences

Both gender and age can influence the clinical presentation and treatment response of ADHD and PTSD, and these factors are important to consider in comorbid cases. Research indicates there are meaningful gender differences in how PTSD and comorbidities manifest and co-occur in adults [247]. Likewise, age differences, a young adult vs. a middle-aged or older adult, may impact diagnosis and management of the comorbidity.

Gender Differences

Epidemiologically, ADHD has historically been diagnosed more often in males, whereas PTSD is more prevalent in females after controlling for trauma exposure [248]. However, adult ADHD is increasingly recognized in women, and women with ADHD appear to have higher rates of social functioning impairment, time perception impairment, and mood and anxiety disorders than men with ADHD [249]. A recent systematic literature review and meta-analysis (not yet peer-reviewed) found that ADHD was linked to a significantly increased risk of developing PTSD in both genders, but the magnitude of the association was greater in women [250]. One reason may be that females

with ADHD are more likely to experience interpersonal traumas (such as sexual assault or domestic violence) [248]. However, this is still speculative.

While both men and women can successfully be treated for ADHD/PTSD comorbidity, women might benefit from an emphasis on internalizing symptom management and holistic support (accounting for high rates of complex trauma), and men might require focus on impulsivity, substance use, and engagement strategies to overcome stigmatization around PTSD. Both genders should receive equal access to combined treatments; evidence suggests that when appropriately treated, women and men have similar capacity for improvement in ADHD symptoms [249] and PTSD recovery [251].

Age Differences

Older adults (middle-aged and beyond) with ADHD are a group only recently garnering clinical attention. A systematic review found that the prevalence of ADHD in adults over 50 is about 2.2% by symptom scales, but only ~0.23% by clinical diagnosis, and an even smaller fraction (~0.09%) receive treatment [252]. This indicates many older adults with ADHD remain undiagnosed or untreated. If such individuals develop PTSD, their ADHD might easily be overlooked in treatment planning. Furthermore, stimulants can cause modest increases in heart rate and blood pressure [200] which in an older patient with hypertension or coronary disease could be riskier. A large cohort study of seniors found a 40% increase in cardiovascular events within the first 30 days of a new stimulant medication which then returns to the baseline chance at 180 days [253]. Further research about treatment effectiveness, polypharmacy with an added stimulant and quality of life changes is needed in this age cohort (50 and up) to establish proper treatment algorithms, not even mentioning how an added PTSD diagnosis might change the clinical picture.

5. Research results and discussion

It emerged that selected articles for the specific comorbidity of ADHD and PTSD in adults were mainly from the last 15 years. Research on children and adolescents had been ongoing for years; however, researchers Adler et al. suspected a correlation already in 2004 [109]. As ADHD is a neurodevelopmental disorder and accompanies patients their whole life, even if later on the symptom burden fades and technically falls short of the diagnostic threshold, much of the research on children and adolescents can be carried over to adults. As the topic is of a more recent timeframe, longitudinal studies on comorbidity outcomes are basically non-existent. Questions such as “If ADHD increases accident rates and therefore PTSD risk, will there be multiple instances of a

PTSD diagnosis, as compared to normal populations?" and "Life expectancy of ADHD patients with comorbidities (substance abuse and accident risk as factors)" arise.

During research, the need for and difficulties implementing an integrated treatment plan crystalized. ADHD and PTSD have overlapping symptoms; however, many symptoms are not, and humans are all different, meaning each patient will have different prominent symptom clusters and different responses and preferences to treatment (pharmacological and psychotherapeutic). It will be a difficult challenge to propose a diagnostic/treatment framework encompassing all possibilities. Therefore, future research should look into implementing bidirectional screening; adult ADHD patients at the point of their diagnosis should be tested for PTSD and vice versa, due to the higher risk of co-occurrence and the exacerbating effects of each disorder. With future studies a possible clinical phenotype classification for the comorbidity might solidify. Furthermore, clinical trial ought to investigate effective integrated treatment plans which combine optimized pharmacological, psychotherapeutic and adjunctive (mindfulness, exercise, etc.) treatments for individuals and their unique symptom profile. Possible novel approaches like MDMA-assisted therapy and ketamine might achieve results in the future, their usage however is tainted by public perception and often prohibited by government regulations.

Lastly, targeted therapies might appear for individual patients, however, currently there is only ongoing research into possible genetic and neurological causes of both diseases. Still, unraveling shared mechanisms is a top priority. Advances in AI and computing power will help progress research. Mendelian-randomization and sibling-comparison studies suggest that ADHD genetic liability causally elevates PTSD risk after trauma exposure, highlighting gene–environment interplay as a key research frontier. Future efforts will likely integrate multimodal imaging with polygenic scoring and longitudinal designs to pinpoint brain–gene pathways that could inform biomarker-driven, circuit-specific interventions.

6. Conclusions

Research over the past decade shows that ADHD and trauma-related disorders frequently co-occur, with ADHD heightening vulnerability to post-traumatic stress and some adults with chronic PTSD describing lifelong attentional difficulties. Clinical observations and epidemiological work converge on an elevated comorbidity rate, while neuroimaging and genetic studies reveal overlapping disruptions that help explain shared symptoms such as inattention, restlessness, and emotional volatility. When both conditions are present, symptom severity and functional impairment are typically greater than with either disorder alone, underscoring the need for integrated assessment

and treatment. These converging lines of evidence point to a still-evolving field in which developmental pathways, precise neurobiological mechanisms, and optimal combined interventions remain important subjects for future investigation.

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