

Schizophrenia or trauma-related psychosis? Schneiderian first rank symptoms as a challenge for differential diagnosis

Stefan Tschöke^{†1}, Carmen Uhlmann¹ & Tilman Steinert¹

Practice points

- Schneiderian first rank symptoms are not specific for schizophrenic disorders, they can also be observed in severe trauma-related disorders. In these cases, according to Diagnostic and Statistical Manual of Mental Disorders-IV-text revision or International Classification of Diseases (ICD)-10, schizophrenia can be misdiagnosed.
- A trauma-related disorder should be taken into account for differential diagnosis if:
 - There is a history of childhood or adulthood traumatization
 - Amnestic episodes are obvious
 - Formal thought disorder is absent
 - Negative symptoms are absent and vivid positive symptoms are present
 - The positive symptomatology is resistant to pharmacotherapy
- The evidence for any kind of pharmacotherapy in treating trauma-related psychopathological symptoms is weak.
- In patients with concomitant symptoms of post-traumatic stress disorder, a specialized trauma therapy has the best therapeutic outcome and could open up new therapy options.

SUMMARY Schneiderian first rank symptoms are still associated with the diagnosis of schizophrenia. Auditory hallucinations in the ‘third person perspective’ in combination with impaired functioning are sufficient for the diagnosis according to Diagnostic and Statistical Manual of Mental Disorders-IV-text revision and International Classification of Diseases-10. However, identical symptoms can be observed in severe dissociative disorders. This article reflects the history of Schneiderian first rank symptoms, shared and nonshared symptoms of schizophrenia and dissociative disorders and the hypothetical role of traumatic events in the origin of these symptoms. Based on the nonshared psychopathological symptoms such as negative symptoms, formal thought disorder and disorganization, suggestions for the differential diagnosis of both disorders and implications for therapy are outlined.

¹Center for Psychiatry & Psychotherapy Südwest, Ulm University, Postfach 2044, D 88190 Ravensburg-Weissenau, Germany

[†]Author for correspondence: stefan.tschoeke@zfp-zentrum.de

Schneiderian first rank symptoms: historical aspects

In the atmosphere of advances in somatic medicine at the end of the 19th century the main objective of psychiatric research was to find somatic correlates for mental illness. At the same time, Sigmund Freud began to develop his psychoanalytical theories in Vienna [1,2]. Thus the German-speaking psychiatry at the beginning of the 20th century was divided in two separated directions, often contradictory among each other: on the one hand, a strictly somatic-orientated clinical psychiatry and on the other hand a purely psychologically-orientated, out-patient-based psychoanalysis. This dichotomy has been reflected in the psychiatric nosology with consequences even now. 'Psychosis' was conceptualized as a mental illness based on a supposed unknown organic disease, belonging to the working field and theories of psychiatrists. 'Neurosis' was conceptualized as mental reaction to supposed unsolved conflicts, definitively without an organic origin and consequently belonging to the working field and theories of psychoanalysis.

Starting in 1989, Emil Kraepelin began describing the dichotomy of manic-depressive illness and 'dementia praecox', which had a huge and lasting impact on the classification of psychotic disorders. He postulated an organic etiology and, although not defining pathognomonic symptoms, conceptualized cognitive decline as characteristic for this type of illness [3]. In 1908, Eugen Bleuler defined the term schizophrenia for the same syndrome at a meeting of the German Psychiatric Society [4]. He described so-called 'core symptoms', which in his opinion reflected an underlying organic brain disorder and 'accessory symptoms', which he regarded as a mental reaction to the organic disease (Table 1) [5,6]. Since Kraepelin schizophrenia was primarily seen as an organic disease. Kurt Schneider was in line with this theory and, in 1939, published a list of symptoms, which, from his experience, were highly characteristic of schizophrenia. He called them first-rank symptoms [7]. This paper, which had significant impact on the future conceptualization of psychiatric nosology, was originally intended merely as a guideline for general practitioners in diagnosing psychotic disorders. In 1957, he repeated his suggestion in another paper [8] and wrote unequivocally that the diagnosis of schizophrenia is given if first rank symptoms are present. They were seen as rather specific but non-mandatory for the diagnosis. With the English

translation of his book (*Clinical Psychopathology*, published in 1959), his diagnostic criteria were spread worldwide and since then have been called Schneiderian first rank symptoms (SFRS) [9].

Schneiderian first rank symptoms are still guiding principles in contemporary diagnostic manuals and textbooks of psychiatry. In the Diagnostic and Statistical Manual of Mental Disorders (DSM)-IV-TR [10] the classification of a disorder as schizophrenia is possible if the patient hears commenting voices or dialogs and general functioning has been impaired for more than 6 months. The main symptom list in the International Classification of Diseases (ICD)-10 criteria is practically identical to SFRS.

However, this combination of psychopathological symptoms can be seen in severe trauma-related disorders as well, which was shown for the diagnosis of dissociative identity disorder (DID) [11–16], borderline personality disorder [17–19] and post-traumatic stress disorder (PTSD) [20,21].

Although this is a very startling finding, seen in light of the history of psychiatric nosology, the SFRS have been given very high importance for the diagnosis of schizophrenia, whereas dissociative disorders have been neglected. One reason could be the fact that dissociative disorders seem to belong to an 'other' sphere, where disorders are thought to be reactive and to require treatment by psychotherapists. Furthermore, there is still a controversial discussion about the concept of the diagnosis DID and the trauma-related etiology [22].

By contrast, we believe that this fact is most interesting and that it could open up new insights in the understanding of the origin of psychotic symptoms and the differences between psychotic and dissociative disorders. This view is justified on the basis that we have left behind the idea of a strict separation of organic and reactive causation models in favor of multifactor interactive models. The review discusses a trauma-related model of SFRS with the focus on potential mediators using the examples of DID, borderline personality disorder and PTSD in comparison to schizophrenia.

Childhood psychological trauma & psychosis

In the last few years, considerable evidence was found for an association between childhood traumatization and severe psychopathological symptoms, including SFRS in adulthood [23–30]. Ross *et al.* compared a clinical sample of patients diagnosed with DID with a sample from the

Table 1. Overview of psychopathological similarities in chronic post-traumatic stress disorder, borderline personality disorder, dissociative identity disorder and schizophrenia.

Psychopathological symptom	Chronic PTSD [†]	BPD [‡]	DID [§]	Schizophrenia [¶]
Bleuler's core symptoms				
Ambivalence	Rare	Rare	Rare	Frequent
Autism	Rare	Rare	Rare	Frequent
Distraction, incoherence	No	No	Inconsistent	Frequent
Blunted affect	No	No	Rare	Frequent
Depersonalization	Frequent	Frequent	Frequent	Sometimes
Passive/apathetic social withdrawal	Rare	No	Rare	Frequent
Emotional withdrawal	Rare	Rare	Rare	Frequent
Schneiderian first rank symptoms				
Audible thoughts	Inconsistent	Inconsistent	Inconsistent	Frequent
Arguing voices	Rare	Rare	Frequent	Frequent
Commenting voices	Frequent	Frequent	Frequent	Frequent
Influences on the body	Rare	Rare	Frequent	Frequent
Thought withdrawal	Inconsistent	Frequent	Frequent	Frequent
Thought insertion	Inconsistent	Frequent	Frequent	Frequent
Thought broadcast	Inconsistent	Rare	Inconsistent	Frequent
Feeling under external influence	Inconsistent	Frequent	Frequent	Frequent
Delusional perception	Rare	Rare	Inconsistent	Frequent
Other symptoms				
Insight into illness	Frequent	Frequent	Frequent	Rare
Bonding	Could be unstable	Stable/unstable	Sometimes stable	Autistic
Amnesia	Rare	Rare	Frequent	Sometimes
Identity alteration	Rare	Rare	Frequent	Inconsistent

[†]Data taken from [20,21,55,63,89,91,101].
[‡]Data taken from [17–19,55,81].
[§]Data taken from [13,15,16,62].
[¶]Data taken from [32,71,72,75].
 BPD: Borderline personality disorder; DID: Dissociative identity disorder; PTSD: Post-traumatic stress disorder.

general population with respect to dissociative symptom patterns, including SFRS, and history of childhood traumatization. The symptom patterns were similar but different in intensity. The authors concluded that these symptoms are a normal reaction of humans to early traumatic life events [31].

In patients with a schizotypal personality disorder or schizophrenia, the prevalence of early traumatization was also found to be increased and associated with psychotic or dissociative psychopathology [32–35]. In a population of 92 ultra-high-risk patients for psychosis, Bechdolf *et al.* found (in 70%) a history of a traumatic event and 22% developed a psychosis during follow up and previous sexual trauma was a predictor for the onset of psychosis in this sample [36]. Comparable results have been reported by Burns *et al.* in a sample of 54 patients with a first episode psychosis [37].

Conus *et al.* analyzed data from 658 patients with a first episode psychosis and found in 83% an exposure to at least one stressful event and in 34% to sexual and/or physical abuse [38]. In a longitudinal UK twin study with 2232 twin children and their families the authors found a correlation between maltreatment or bullying by peers and the report of psychotic symptoms at an age of 12 years. This correlation was not found for accidents [39]. The connection between bullying by peers and psychotic symptoms had been found in an earlier study by Campbell *et al.* in a population of adolescents, as well [40].

The etiological mechanism leading from childhood traumatization to psychotic experiences in adulthood is unknown in detail. From a biological view, it is clear that life-threatening events have effects on the stress system. Braun and Bogerts showed in animal models that

deprivation experiences have negative influences for neuronal and synaptic plasticity, especially for limbic circuits, which is important for social and emotional control and learning [41]. In this context, the hypothalamus–pituitary–adrenal regulation system was influenced by a pathological down-regulation. These negative effects of early-life stress were stable over time and it was suggested that they were mediated by epigenetic modification of gene expression [42,43]. That could explain an impaired resilience and the inability to cope with acute or chronic stress [44,45]. A traumagenic neurodevelopmental model to explain the high prevalence of early traumatic events in patients diagnosed with schizophrenia and their psychopathology was offered by Read *et al.* in 2001 [46].

In patients with schizophrenia, functional neuroimaging studies found abnormalities in functional brain networks. Some authors argue that SFRS could be a consequence of dysconnectivity, which causes failures of self monitoring [47]. Fitting with this, abnormal processing in functional pathways has been found in neuroimaging studies, which could explain auditory hallucinations in this group [48].

Another way to explain positive psychotic symptoms is a cognitive one. Two cognitive models try to explain verbal auditory hallucinations. One model is based on inner speech and one on intrusions from memory. In traumatized patients the symptoms can be seen as cognitive or meta-cognitive appraisals that are associated with the trauma. In this model, verbal auditory hallucinations represent suppressed trauma-related associations impinging on consciousness [49–52]. Cognitive biases also seem to be important for understanding psychotic symptoms in patients with a borderline personality disorder [53].

Dissociation as a reaction to trauma is well known [54]. Van der Hart *et al.* published a trauma-related structural dissociation model based on the work of Janet [55]. Janet had described dissociation as a splitting of the self during traumatization [56]. During traumatization, biologically determined behavioral defence systems are activated and reactivated in triggered situations. In this model, these parts of the personality are called emotional parts of the personality and are differentiated to apparently normal parts of the personality (ANPs). As an ANP, action systems for normal living are activated and traumatic memories are avoided [55]. In patients suffering from DID multiple ANP and

emotional parts of the personality systems coexist side by side with amnesia for the activities of the other systems (Figure 1). SFRS could be seen as thoughts, perceptions, behaviors or sensations of emotional parts of the personality impinging on the consciousness of the ANP. Figure 2 shows a spontaneous picture drafted by a female patient with DID that is impressively similar to the structural dissociation model.

Schizophrenia & severe dissociative disorders: similarities & differences

Historically, positive psychotic symptoms such as delusions and hallucinations have been viewed as most characteristic for schizophrenia. However, it is well-known that such psychotic symptoms can also occur in people with dementia, depressive or manic states, people with intoxications or withdrawal syndromes, chronic alcohol abuse, personality disorders, PTSD, under sensory deprivation and even among healthy subjects [57–60]. Even SFRS, supposedly being specific for schizophrenia, were more frequently seen in patients diagnosed with DID in comparison with schizophrenia [11–13]. Phenomenological examinations in psychiatric populations showed that there is no specific difference between voice hearing in dissociative disorders and schizophrenia [61,62]. Furthermore, Anketell *et al.* showed that voice hearing is not rare in patients with chronic PTSD, and this phenomenon is related to dissociation as a possible mediator [63]. Obviously, psychotic symptoms and even SFRS are not specific for any diagnosis but the diagnostic value depends on concomitant other symptoms such as depression, negative symptoms or thought disorder.

Table 1 shows shared and nonshared symptoms of schizophrenia and trauma related disorders. Owing to the great psychopathological similarities between schizophrenia and DID (the most severe dissociative disorder) the discrimination between these disorders is difficult in the current diagnostic manuals if only positive psychotic symptoms are taken into account. Therefore, schizophrenia is the most frequent misdiagnosis in patients suffering from DID [12,14,16,64–68]. The early core symptoms of schizophrenia described by Bleuler are negative symptoms [6]. Negative symptoms can be helpful for differential diagnosis [69]. Also formal thought disorder can be of relevance for differential diagnosis.

Aware of the psychopathological similarities and the problem for differential diagnosis, Steinberg *et al.* developed the Structured Clinical

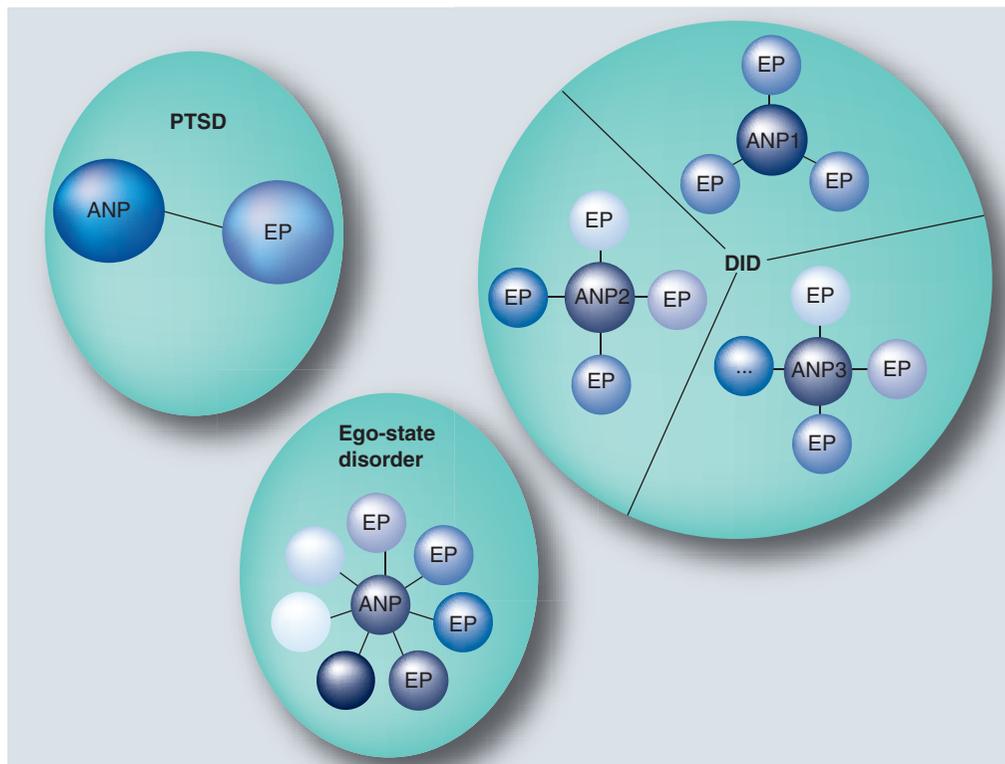


Figure 1. Schema of trauma-related structural dissociation. During traumatization, biologically determined behavioral defence systems are activated and reactivated in triggered situations. These parts of the personality are called EPs and are differentiated to ANPs. As an ANP, action systems for normal living are activated and traumatic memories are avoided. In this model, Schneiderian first rank symptoms can be seen as thoughts, perceptions, behaviors or sensations of EPs impinging on the consciousness of the ANP.

ANP: Apparently normal parts of the personality; DID: Dissociative identity disorder; EP: Emotional parts of the personality; PTSD: Post-traumatic stress disorder.

Interview for Dissociative Disorders [70]. In a study using this interview they found a different range, severity and nature of five dissociative symptoms (amnesia, derealization, depersonalization, identity confusion and identity alteration) in schizophrenia and DID. Patients with schizophrenia showed none-to-mild isolated dissociative symptoms, whereas patients with DID showed moderate-to-severe symptoms. These differences can guide differential diagnosis (Table 2) [71]. To date, the Structured Clinical Interview for Dissociative Disorders is still the gold standard for the diagnosis of dissociative symptoms and disorders. Furthermore, this working group published psychopathological differences between these two disorders (Table 2). The differentiation of DID patients from schizophrenic patients is not possible with SFRS alone, tests for dissociation are essential for successful differential diagnosis and, subsequently, treatment planning [72].

According to the DSM-IV, the diagnosis of DID is made if there are signs for multiple personalities, switches between them and amnesia for the activities of the other personalities. Dell published a new model of DID [15,73,74]. He argued that the criteria for the diagnosis DID in the DSM-IV-TR omit most of the dissociative phenomenology in DID. In his new subjective/phenomenological model he described two major clusters of dissociative phenomena. One cluster includes switching between multiple personalities in combination with amnesia, according to the criteria in DSM-IV-TR, the second cluster contains intrusions into functioning and sense of self by multiple personalities. Phenomenologically, a lot of symptoms are not different from SFRS seen in schizophrenic disorders.

To complicate matters, as shown earlier, in populations of people with schizophrenia, a high prevalence of childhood trauma history

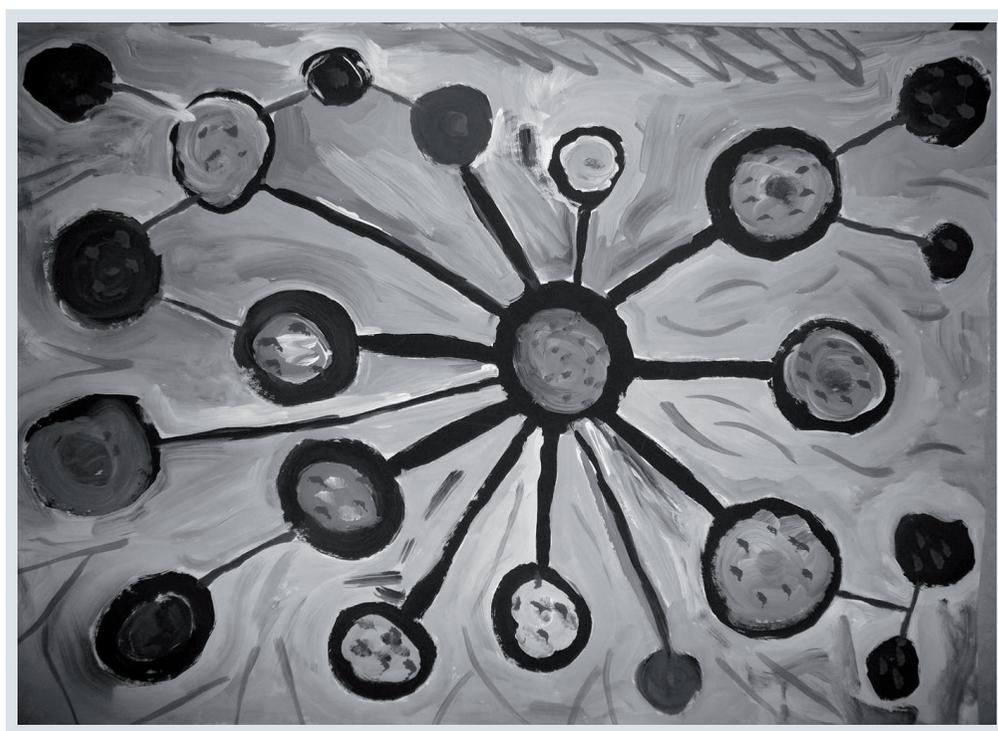


Figure 2. Patient's spontaneous picture about her identity confusion.

and dissociation was found as well [33,75–77]. Childhood trauma history was associated with the severity of psychopathological symptoms. Ross and Keyes postulated a trauma dissociation subgroup within schizophrenia [76]. Sar *et al.* replicated these findings and described a subgroup of patients with high dissociation and history of childhood trauma in a group of patients with schizophrenia [32]. A history of childhood traumatization was not related to core features of the schizophrenic disorder but with dissociation scores and symptoms. The trauma-related dissociative subgroup was characterized by more psychiatric comorbidities, secondary features of DID and SFRS. Also in this group the comorbidity with a borderline personality disorder was high. While Ross *et al.* postulated a continuum between nondissociative schizophrenia and DID [78], Sar *et al.* described a duality model with two distinct (dissociative and psychotic) psychopathologies with a complex relationship [32]. According to these findings, SFRS might have different etiologies, one of them being trauma related and dissociative in nature, which was already postulated by Ross *et al.* in an earlier paper [79] and there might be a proximal impact of dissociation to schizophrenic symptomatology [80].

Borderline personality disorder: a disorder on the 'border'

The diagnosis of borderline personality disorder is clinically associated with a wide range of psychopathological symptoms including SFRS (Table 1), resulting in problems for differential diagnosis and treatment planning [18,81]. According to the DSM-IV-TR, 256 combinations of the nine potential categorical items are possible to fulfill the diagnostic criteria. Borderline personality disorder is characterized by a high prevalence of early childhood traumatization [82] and dissociation [83,84]. The prevalence of psychotic symptoms in this disorder is reported from 27 to 40% [17,85]. With respect to psychotic symptoms, in DSM-IV-TR the criterion nine is of special interest, which describes psychotic symptoms as a "temporary and stress-related phenomenon". However, in a review Barnow *et al.* concluded that psychotic symptoms are actually common in borderline personality disorder, often permanent and severe, but in the long-term course they do not predict a psychotic disorder [19]. In patients suffering from a borderline personality disorder with psychotic symptoms, a schizophrenic disorder can be misdiagnosed. The clinical differentiation between hallucinations and so-called 'pseudohallucinations' has low validity and is

ambiguous [86]. This construct is not helpful for differential diagnosis. From the perspective of the trauma-related structural dissociation of the personality model of van der Hart *et al.*, this disorder is an example of secondary structural dissociation, and psychotic experiences can be seen as intrusions of emotional parts of the personality. This model could help the clinician to understand some of the behaviors of the respective patients [55]. With respect to treatment planning, a screening for a comorbid dissociative disorder or PTSD should be recommended, because a comorbidity with dissociative disorder has been found in a relevant proportion of patients with borderline personality disorder [87,88].

PTSD & psychotic symptoms

There is growing evidence for psychotic symptoms representing one potential experience of PTSD [21,89–94]. Brewin *et al.* studied voice hearing in war veterans with and without PTSD, a civilian population with PTSD and healthy

controls with trauma exposure [95]. The results yielded further evidence for the dissociative nature of PTSD and voice hearing in this disorder [95]. Shevlin and coworkers analyzed data from the National Comorbidity Survey conducted in the USA and found a cumulative relationship between interpersonal traumatic events and psychosis [96]. Rape, sexual assault and physical assault in childhood were related to visual and auditory hallucinations [97]. In a further analysis of the data they found a subgroup with PTSD symptoms in combination with psychotic symptoms and they postulated a psychotic PTSD subtype [98]. By contrast, the results of a study by Gaudiano and Zimmermann who examined 1800 psychiatric outpatients do not support a psychotic subtype of PTSD [99].

Psychotic symptoms can be a symptom of PTSD after traumatization in childhood and adulthood. The phenomenology of hallucinations is comparable with the experiences of schizophrenic patients [100]. The origin of these

Table 2. Differences in shared psychopathological symptoms in schizophrenia and dissociative identity disorder.

	Schizophrenia	DID
Dissociative symptoms (amnesia, derealization, depersonalization, identity confusion and identity alteration)	None-to-mild isolated symptoms in the context of psychotic symptoms	Moderate-to-severe symptoms
Identity confusion/disturbance	Lack of sense of identity and one's role in society	Alterations in one's identity
Auditory hallucinations	Hallucinations other than the voices of alternate personalities, primarily outside their head	Auditory hallucinations reflect dialogs between alternate personalities inside their head
Schneiderian symptoms and delusions	Bizarre delusions, paranoid delusions	Delusions are "delusions of several personalities" or of bodily changes representative of the different personalities
Other psychotic symptoms	Thinking characterized by incoherence or loosening of associations Catatonic behavior Chronic flat affect	Absent
Reality testing	Impaired reality testing	Intact; "as if" descriptions of dissociative symptoms are typical
Comorbid diagnosis	The full depressive or manic syndrome is either not present, developed after psychotic symptoms, or was brief in duration relative to the duration of other psychotic symptoms	The full depressive or manic syndrome may coexist with the dissociative syndrome
Impairment in functioning	Functioning in such areas as work, social relations and self-care is markedly below the highest level achieved before onset of the disturbance	Any impairment in functioning is usually temporary
Course of symptoms and syndrome	Continuous signs of the disturbance for at least 6 months	Signs of the disturbance may be intermittent; rapid fluctuations in symptoms, mood and degree of impairment may occur

DID: Dissociative identity disorder.
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phenomenological ‘psychotic’ symptoms is still unknown. Dissociation, thought suppression, content of trauma and major depression have been associated with psychotic symptoms. These are different from flashbacks in PTSD and are more symbolically associated with the trauma [63]. The phenomenological and biological evidence for the validity of a subtype of PTSD with psychotic symptoms increases but needs to be validated. Provisional criteria for PTSD with psychotic symptoms have been proposed (Box 1) [101].

Implications for therapy

The clinician has the problem that trauma-related disorders like DID often fulfill the criteria for the diagnosis of schizophrenia. This can end in a misdiagnosis of a schizophrenic disorder, overlooking a dissociative or post-traumatic disorder. To date, the evidence for specific pharmacotherapy in treating trauma-related psychopathological symptoms is weak [102,103]. Consequently a symptom-orientated pharmacological treatment is not advisable in most cases. According to the guidelines from the International Society for the Study of Dissociation, in DID a phase-orientated psychotherapeutic treatment is recommended [104]. In patients with symptoms of PTSD and a history of childhood traumatization, a specialized trauma therapy has the best therapeutic outcome and could open up new therapy options [105,106]. However, in most therapy programs a comorbid psychotic disorder was an exclusion criterion. By contrast, a pilot study by Christopher *et al.* explored exposure-based cognitive-behavioral treatment of PTSD in adults with schizophrenia or schizoaffective disorder and concluded that this therapy was successful in this population as well, without increased adverse events [107]. Therefore, a specific psychotherapeutic treatment can be option for trauma-related psychopathological symptoms with different comorbidity.

Furthermore, Beavan and Read explored the prevalence of voice hearing in a general population sample and found that this factor was a significant predictor of emotional distress and a predictor of contact with mental health services. They concluded that the content of voice hearing should be more in the focus of therapy [108].

Conclusion

Trauma-related psychopathological symptoms can be similar to schizophrenic psychopathology according to the DSM-IV-TR or ICD-10, and therefore schizophrenia can be misdiagnosed [11]. In particular, SFRS were clinically associated with schizophrenic disorders, but it was shown that this symptomatology can be seen as a range from general populations to psychiatric populations with severe mental illnesses [59,109]. Location, number, volume and personification of auditory verbal hallucinations can not differentiate between psychotic or healthy individuals. However, the emotional response to the content, the frequency and the control over the voices seem to be relevant for differentiation [110]. A trauma-related disorder should be taken into account for differential diagnosis and comorbidity, especially if the positive symptomatology is resistant to pharmacotherapy and if there is a history of childhood or adulthood traumatization. Amnestic episodes, lack of formal thought disorder, dominant positive symptoms, and lack of negative symptoms can also be relevant for diagnosis. Future research in the field of psychopathological symptoms is needed to help clinicians to distinguish between trauma-related psychopathological symptoms and symptoms of another etiology.

Future perspective

Taking into account the still rather limited contribution of neurosciences to psychiatric diagnosis and differential diagnosis, clinical diagnoses

Box 1. Proposed provisional diagnostic criteria for post-traumatic stress disorder with secondary psychotic symptoms.

- DSM-IV-TR criteria for PTSD
- Positive psychotic symptoms such as delusions and/or hallucinations
 - Psychotic features are not confined exclusively to episodes of re-experiencing or flashbacks and should be distinguished from DSM-IV-TR PTSD criterion B3: “acting or feeling as if the traumatic event were recurring”
 - No formal thought disorder
 - No brief psychotic disorder
 - PTSD precedes the onset of psychotic features
 - No history of psychotic episodes prior to the traumatic event(s)

DSM: Diagnostic and Statistical Manual of Mental Disorders; PTSD: Post-traumatic stress disorder. Reproduced with permission from [101].

in psychiatry are still made by interpretation of psychopathological symptoms in combination with life history. There is comprehensive evidence that SFRS are a common symptom in trauma-related disorders and are not limited to schizophrenic disorders. Therefore, research in clinical psychopathology is an important field for diagnosis and classification of mental disorders, which can be considered as highly relevant for the ongoing process in the development of diagnostic manuals. In the topical discussion on the DSM-V, new trauma-related diagnoses like 'Developmental Trauma Disorder' and 'Disorders of Extreme Stress Not Otherwise Specified' have been proposed to be included. With regard to the disorder 'schizophrenia' the proposed revision contains two criterion A symptoms for the diagnosis, with the consequence that the presence of one SFRS is no longer sufficient for diagnosis. In the proposed

revision of the disorder 'Dissociative Disorders Not Otherwise Specified', an acute type of mixed dissociative symptoms with psychotic experiences has been included.

It would be desirable that the results from biological, social and psychological research were brought together resulting in a holistic view of psychotic psychopathology instead of creating separated viewpoints and theories.

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