Sensation/novelty seeking in psychotic disorders: A review of the literature

Vaios Peritogiannis

Sensation/novelty seeking (SNS) is a trait that is biologically based and highly heritable, and is associated with dopamine activity, and refers to a person's tendency to seek varied, novel, complex, and intense sensations and experiences. A total of 38 studies were included in this review, involving 2808 patients and 2039 healthy controls. There is consistent evidence that this trait is independently associated with alcohol and substance abuse in patients with schizophrenia and related disorders. The estimation of SNS would help clinicians to identify patients at risk for abuse. There is also some evidence that higher SNS levels may relate to medication non-adherence and aggressive behavior, but studies are scarce. SNS was found not to be related to suicidality, whereas in the fields of patients' quality of life and psychopathology results are contradictory, but most studies show no possible association. Several studies suggest that SNS is lower in psychotic patients compared to controls, whereas abusing patients, who probably have high SNS levels are often excluded from research.

Key words: Novelty seeking; Personality; Psychosis; Sensation seeking; Schizophrenia; Substance abuse

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Core tip: This review summarizes current research on the personality trait sensation/novelty seeking (SNS) in psychotic disorders. There is an emerging literature on SNS in psychotic patients, suggesting that this trait is associated with patients’ alcohol and substance misuse. Some evidence suggests that SNS may be related to medication non-adherence and aggressive behavior, whereas data on other illness dimensions, such as quality of life and psychopathology are scarce and controversial. In general, patients with psychotic disorders appear to have lower SNS levels than healthy controls, but abusing patients, who probably have high SNS levels are often excluded from research.
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INTRODUCTION

Research on schizophrenia and related syndromes has been focused on the study of psychopathology, and the investigation of neurobiology and genetics of these debilitating disorders. Numerous previous and more recent publications address these important issues in psychotic disorders. Biological and psychosocial treatments and treatment delivery has also been the objective of many studies. Literature on patients’ personality and character in such disorders is far more limited. However, the evaluation of personality traits is important for the better understanding of the person suffering from psychosis and for treatment individualization. Clinicians should always take into account patients’ personality, as proposed by scholars in major educational psychiatric texts[3,4].

At recent years an increasing number of studies have been edited for the investigation of personality traits of psychotic patients and the effect of personality on the development and expression of symptomatology[2], relapse[3,4], social functioning[4] and outcome[5].

The concept of the personality trait called “sensation seeking” (SS) has been originally introduced by Zuckerman[6] who defined it as a person’s tendency to seek varied, novel, complex, and intense sensations and experiences, and the willingness to take physical, social, legal, and financial risks for the sake of such an experience. Cloninger[7,8] used the term “novelty seeking” (NS) to describe a similar to SS concept in his temperament and character model. Previous and more recent studies support that these two concepts are identical[9,10]. The correlation of SS to NS was found to be as high as 0.68 in the study edited by Zuckerman and Cloninger[9]. Both investigators suggested sensation/novelty seeking (SNS) to be biologically based and highly heritable, and several studies support this notion[11,12]. Moreover, the association of SNS with genes such as DRD4 and COMT, which regulate dopamine activity and are implicated in the pathogenesis of psychotic disorders, has been shown by researchers[13,14]. It seems that SNS is mediated by pathophysiological mechanisms at the neurotransmitter level, and may be particular relevant in psychotic disorders, because dopamine and other neurotransmitters are involved in psychotic symptomatology. It should be noted that concepts related to SNS exist in other personality models, such as the Openness to experiences in the Costa and McCrae’s big five personality model[15].

SNS can be reliably measured with the use of instruments such as the Sensation Seeking Scale[10] or as one of the traits included in the Tridimensional Personality Questionnaire (TPQ)[17], or the more recent Temperament and Character Inventory (TCI)[18] which were developed by the researchers. SNS has been studied in healthy persons and mental patients and was found to be associated with alcohol/substance abuse[19,20], in patient populations and risky behavior in healthy subjects[21]. The evidence for the impact of this trait in psychosis is limited. The aim of the present report is to review the literature on SNS in psychotic patients and to stress its clinical relevance.

SEARCH REFERENCES

A search in the database of PubMed was conducted, for English-language articles published up to August 2014, with the combination of each of the search terms “sensation seeking”, “novelty seeking”, with each of the terms “schizophrenia” and “psychosis”. Additional search used the scales names (Sensation Seeking Scale, Tridimensional Personality Questionnaire, Temperament and Character Inventory) in combination with the terms “schizophrenia” and “psychosis”. References cited in the originally retrieved publications were searched to identify additional potentially relevant studies. Only studies in which a standardized and valid tool was used for personality traits’ evaluation were included in the review. Regarding diagnosis this review comprised studies on patients with schizophrenia and related psychoses. No limits were set in the number of participants in the studies to be included in this review. All studies in which the levels of SNS in psychotic patients were assessed with the use of a valid instrument were included, regardless the study objective and outcome (psychopathology, alcohol/substance abuse, quality of life, medication adherence, suicidality, violent behavior, and other illness dimensions). Finally, all studies comparing SNS levels between patients and control groups were included.

SENSATION/NOVELTY SEEKING IN PATIENTS WITH PSYCHOTIC DISORDERS

The initial search retrieved 130 articles. Most of them were excluded after reading the abstract. The additional search revealed one more relevant paper. Together with the relevant references a total of 38 studies were included in this review, involving 2808 patients and 2039 healthy controls, and 415 patients’ first degree relatives.

Results are presented in Tables 1-7. Each table refers to a different study objective and presents briefly the main findings of studies.

SNS and psychopathology

Studies on the possible effect of SNS on the symptomatology in psychotic patients yielded inconsistent results (Table 1). Although SNS levels were correlated to psychotic symptoms[22], poor insight[23] and executive...
SNS and alcohol/substance abuse

The role of SNS in psychotic patients’ alcohol/substance abuse has been a field of extensive investigation (Table 2), including the first study on SNS in schizophrenia patients\(^{[29]}\). Eight studies have examined SNS in abusing patients and they consistently reported that this trait is associated with alcohol/substance abuse. Notably, 3 studies are restricted to male patients\(^{[29,32,34]}\). Interestingly, in the most recent study in the field, abusing subjects with and without schizophrenia had higher SS levels compared to non-abusing schizophrenia patients.\(^{[29]}\)

### Table 1  Sensation/novelty seeking and psychopathology

| Ref.          | Trait-instrument | Main findings                                                                 |
|---------------|------------------|-------------------------------------------------------------------------------|
| Guillem et al\(^{[22]}\) | NS, TCI          | Positive correlation between NS and the psychotic symptom dimension; lower NS scores in patients compared to controls. |
| Boeker et al\(^{[23]}\)   | NS, TCI          | NS was found not to be related to psychopathology. No differences in patients and controls. |
| Ritsner et al\(^{[24]}\)  | NS, TPQ          | Increased NS was associated with poor insight.                                |
| Guillem et al\(^{[25]}\) | NS, TCI          | Higher NS levels in patients affected executive function; patients scored lower than controls on NS. |
| Cortés et al\(^{[26]}\) | NS, TCI-R        | NS was found not to be related to psychopathology. Moderate difference in patients and controls. |
| Liraud et al\(^{[30]}\) | SS, SSS          | High SS was associated with increased risk of substance abuse.               |
| Dervaux et al\(^{[31]}\) | SS, SSS          | Higher levels of SS were associated with substance abuse.                     |
| Kim et al\(^{[32]}\)    | NS, TCI          | Dual-diagnosis patients showed greater novelty seeking.                      |
| Bizzarri et al\(^{[33]}\) | SS, SCI-SUBS     | Abusing patients had higher SS scores.                                       |
| Dervaux et al\(^{[34]}\) | SS, SSS          | Higher SS scores in the abusing group.                                       |
| Dervaux et al\(^{[35]}\) | SS, SSS          | Higher mean scores on SS in patients with a lifetime history of abuse.        |
| Zhornitsky et al\(^{[36]}\) | SS, SSS         | SS total score was significantly higher in abusing patients, irrespectively of the diagnosis of schizophrenia. |

NS: Novelty seeking; TPQ: Tridimensional personality questionnaire; TCI: Temperament and character inventory; TCI-R: TCI revised.

### Table 2  Sensation/novelty seeking and alcohol/substance abuse

| Ref.          | Trait-instrument | Main findings                                                                 |
|---------------|------------------|-------------------------------------------------------------------------------|
| Van Ammers et al\(^{[27]}\)  | NS, TPQ          | Significant correlation of NS with a history of alcohol/cannabis abuse.       |
| Liraud et al\(^{[31]}\) | SS, SSS          | High SS was associated with increased risk of substance abuse.               |
| Dervaux et al\(^{[32]}\) | SS, SSS          | Higher levels of SS were associated with substance abuse.                     |
| Kim et al\(^{[33]}\)    | NS, TCI          | Dual-diagnosis patients showed greater novelty seeking.                      |
| Bizzarri et al\(^{[34]}\) | SS, SCI-SUBS     | Abusing patients had higher SS scores.                                       |
| Dervaux et al\(^{[35]}\) | SS, SSS          | Higher SS scores in the abusing group.                                       |
| Dervaux et al\(^{[36]}\) | SS, SSS          | Higher mean scores on SS in patients with a lifetime history of abuse.        |
| Zhornitsky et al\(^{[37]}\) | SS, SSS         | SS total score was significantly higher in abusing patients, irrespectively of the diagnosis of schizophrenia. |

SS: Sensation seeking; NS: Novelty seeking; SSS: Sensation Seeking scale; TPQ: Tridimensional personality questionnaire; TCI: Temperament and character inventory; SCI-SUBS: Structured clinical interview for the spectrum of substance use.
adherence in patients, independently from a history of substance abuse in one study, whereas in the other substance abuse was an exclusion criterion.

SNS and suicidality
Two studies on the effect of personality on suicidality in schizophrenia patients reported consistently no association of SNS with previous suicide attempts (Table 5). Notably, in both studies current or past history of alcohol/substance abuse was an exclusion criterion.

SNS in other aspects of psychotic disorders
One study yielded no association of SNS with patients’ disability; SNS was found also not to be related to coping and recovery style in psychotic disorders in another report. Two studies addressed the

Table 3  Sensation/novelty seeking and quality of life

| Ref. | n | Trait-instrument | Main findings |
|------|---|-----------------|---------------|
| Hansson et al[37] | 104 outpatients with schizophrenia, schizophreniform disorder, or schizoaffective disorder | NS, TCI | Several personality dimensions, but not NS were correlated to subjective quality of life |
| Ritsner et al[38] | 90 inpatients and outpatients with schizophrenia | NS, TPQ | Higher levels of NS were associated with better general quality of life |
| Kurs et al[40] | 47 schizophrenia outpatients, 47 non-affected siblings, 56 healthy subjects | NS, TPQ | Harm avoidance but not NS was associated with general quality of life. There were no differences in NS between patients, siblings and controls |
| Margetić et al[41] | 120 schizophrenia outpatients, 120 first degree relatives, 129 healthy controls | NS, TCI | Quality of life was not related to NS. Patients scored lower on NS compared to controls, and similar to relatives |
| Jetha et al[42] | 41 outpatients with schizophrenia spectrum disorders, 41 healthy controls | NS, TCI | NS was not related to any aspect of quality of life. Patients had significantly lower scores on NS than controls |

NS: Novelty seeking; TPQ: Tridimensional personality questionnaire; TCI: Temperament and character inventory.

Table 4  Sensation/novelty seeking and medication adherence

| Ref. | n | Trait-instrument | Main findings |
|------|---|-----------------|---------------|
| Liraud et al[43] | 45 inpatients with schizophrenia and related psychoses, 58 inpatients with mood disorders | SS, SSS | SS was associated with poor medication adherence |
| Aukst Margetić et al[44] | 76 schizophrenia outpatients, Substance abuse was an exclusion criterion | NS, TCI | NS was associated with medication non-adherence |

SS: Sensation seeking; NS: Novelty seeking; SSS: Sensation Seeking scale; TCI: Temperament and character inventory.

Table 5  Sensation/novelty seeking and suicidality

| Ref. | n | Trait-instrument | Main findings |
|------|---|-----------------|---------------|
| Albayrak et al[45] | 94 schizophrenia outpatients, 46 attempters | NS, TCI | No association of NS with suicide attempts |
| Aukst Margetić et al[46] | 120 schizophrenia outpatients, 29 with attempted suicide | NS, TCI | No association of NS with suicidality and suicide attempts |

NS: Novelty seeking; TCI: Temperament and character inventory.

patients and healthy controls.[36]

SNS and quality of life/social functioning
Five studies (Table 3) have addressed the possible effect of SNS in subjective quality of life in schizophrenia patients. With one exception, results are consistent in that SNS is not associated with quality of life in patients’ population, in contrast with other traits, such as harm avoidance. Only the study of Ritsner et al[38] showed that higher NS levels were associated with better general quality of life.

SNS and treatment adherence
Only two studies (Table 4) were conducted with the objective to assess the impact of SNS on medication adherence, involving in-and outpatients. Higher SNS scores were associated with poor medication adherence in patients, independently from a history of substance abuse in one study,[42] whereas in the other[43] substance abuse was an exclusion criterion.

SNS and suicidality
Two studies on the effect of personality on suicidality in schizophrenia patients reported consistently no association of SNS with previous suicide attempts (Table 5). Notably, in both studies current or past history of alcohol/substance abuse was an exclusion criterion.

SNS in other aspects of psychotic disorders
One study[36] yielded no association of SNS with patients’ disability; SNS was found also not to be related to coping and recovery style in psychotic disorders in another report.[48] Two studies[47,49] addressed the
possible association of violent behavior of patients with schizophrenia with SNS. Both found that higher SNS levels were correlated with higher scores on the Overt Aggression Scale (OAS), but in the study of Lejoyeux et al\[49\] SS did not appear in the logistic regression to be a risk factor for aggressive behavior (Table 6).

Table 6  Sensation/novelty seeking and other illness dimensions

| Ref.            | n                          | Trait-instrument | Objective                          | Main findings                                                                                                                                 |
|-----------------|----------------------------|------------------|------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------|
| Herrán et al\[46\] | 62 schizophrenia outpatients, 43 healthy subjects | NS, TPQ         | Disability                         | Several personality traits, but not NS were associated with disability. There were no differences in NS between patients and controls          |
| Fresán et al\[47\] | 102 schizophrenia outpatients (61 violent) Current (the last 4 mo) alcohol/substance abuse was an exclusion criterion | NS, TCI         | Aggressive/violent behavior        | NS was a risk factor for violent behavior                                                                                                  |
| Modestin et al\[48\] | 64 inpatients with schizophrenia spectrum disorders | NS, TPQ         | Coping/recovery style in psychotic illness | No association with NS                                                                                                                     |
| Lejoyeux et al\[49\] | 100 schizophrenia inpatients | SS, SSS         | Aggressive/violent behavior        | SS was not associated with patients’ aggressive behavior. Sub-scores on SSS were correlated to the OAS scores                               |

SS: Sensation seeking; NS: Novelty seeking; SSS: Sensation Seeking scale; TPQ: Tridimensional personality questionnaire; TCI: Temperament and character inventory; OAS: Overt Aggression scale.

Table 7  Sensation/novelty seeking in psychotic patients and control groups

| Ref.            | n                          | Trait-instrument | Main findings                                                                 |
|-----------------|----------------------------|------------------|--------------------------------------------------------------------------------|
| Szöke et al\[50\] | 45 schizophrenia inpatients 126 controls | NS, TPQ         | No differences in NS between groups                                             |
| Ritsner et al\[51\] | 90 schizophrenia outpatients 136 controls Drug/alcohol abuse was an exclusion criterion | NS, TPQ         | No differences in NS between groups                                             |
| Calvó de Padilla et al\[52\] | 11 chronic untreated schizophrenia patients 11 first-degree relatives 12 controls | NS, TCI         | No differences in NS between groups                                             |
| Farhady et al\[53\] | 69 schizophrenia inpatients 50 healthy controls | SS, SSS         | Lower SS in patients                                                          |
| Hori et al\[54\] | 86 schizophrenia patients 115 healthy controls Substance abuse during the past 6 mo was an exclusion criterion | NS, TCI         | Lower NS in patients                                                          |
| Smith et al\[55\] | 35 schizophrenia in- and outpatients 34 non-psychotic siblings 63 controls 56 controls’ siblings | NS, TCI         | No differences in NS between groups. No association of NS with psychopathology dimensions |
| Gonzalez-Torres et al\[56\] | 61 inpatients with schizophrenia or schizophrenia spectrum disorders 59 first degree relatives 64 healthy controls Substance abuse was an exclusion criterion 97 first-degree relatives 106 controls | NS, TCI         | NS scores were not different in patients and controls; patients scored higher on NS than relatives |
| Ohi et al\[57\] | 99 schizophrenia patients 179 controls Substance-related disorders were an exclusion criterion for patients | NS, TCI         | Lower NS in patients                                                          |
| Sim et al\[58\] | 48 patients with schizophrenia or schizoaffective disorder 97 first-degree relatives 106 controls History of substance use was an exclusion criterion | NS, TCI         | No differences in NS between groups                                             |
| Miralles et al\[59\] | 161 schizophrenia inpatients, 214 healthy controls | NS, TCI-R       | No differences in NS between groups; in males the number of psychiatric admissions positively correlated with NS                           |
| Hori et al\[60\] | 106 schizophrenia outpatients 247 healthy controls Substance use was an exclusion criterion for controls | NS, TCI         | NS was found to be significantly lower in symptomatic (n = 72) but not in remitted patients |

NS: Novelty seeking; TPQ: Tridimensional personality questionnaire; TCI: Temperament and character inventory; TCI-R: TCI revised; SSS: Sensation Seeking scale; SS: Sensation seeking.
SNS levels in psychotic patients and controls

As appears in Table 7 there are 10 studies on the estimation of SNS levels in psychotic patients. Additionally there are 9 studies described in other tables (see Tables 1, 3 and 6) in which SNS levels on patients and healthy controls where examined among other objectives. Overall results are inconclusive. Seven studies (see Tables 1, 3 and 7) suggest that SNS levels are lower in psychotic patients, whereas in most (11 studies, see Tables 1, 3, 6 and 7) no difference is observed. Interestingly, in one of the most recent studies[60] NS was found to be significantly lower in symptomatic but not in remitted patients. Recently Ohi et al[61] performed a case-control study and a meta-analysis comprising seven studies to estimate personality differences between patients and healthy controls. Regarding NS, they found no overall differences in scores between patients and controls. However, there was evidence of heterogeneity among studies for NS, and in the subgroup analysis the effect size for this trait was affected by study location. Asian populations presented significant difference between patients and controls, whereas in European populations there was no difference in NS between patients and controls, suggesting a possible cross-cultural difference.

DISCUSSION

This review extends the findings of two previously published meta-analyses[57,61], in which only studies using the TPQ/TCI were included, on the impact of the SNS trait on psychotic disorders. Here, a total of 38 studies are included referring to the similar concepts of SS and NS in psychotic patients. There is an emerging literature on the personality trait SNS in psychotic patients. There is consistent evidence that this trait is independently associated with alcohol and substance abuse in patients with schizophrenia and related disorders. These results are in line with research on abusing subjects without a comorbid psychotic disorder.[62] It seems that SNS increases the risk of substance abuse in psychotic patients as in other populations. Importantly psychotic patients demonstrate high abuse rates and abuse is associated with poor prognosis.[63] It may be clinically relevant to inquire for SNS in psychotic patients, particularly first episode patients as it might have a predictive value in identifying those who may be prone to abuse. Accordingly, this may determine the implementation of specific interventions.

There is also some evidence for the impact of SNS on other important aspects of psychosis, such as treatment adherence and violence. Higher SNS levels have been related to medication non-adherence and seem to increase the risk of patients’ aggressive and violent behavior, but studies are scarce. Taken together these findings suggest that SNS may affect psychotic disorders’ course and prognosis in several ways. For instance, inadequate medication adherence and a history of substance abuse are both predictive of an unfavorable outcome. This is in line with previous evidence regarding personality traits such as neuroticism,[5] which suggests that personality dimensions are associated with psychotic disorders’ outcome.

Personality traits including SNS have been also studied in psychotic patients who have attempted suicide. Suicidality is not uncommon in schizophrenia, and up to 5% of patients complete suicide[64]. Two studies have addressed this issue, and found that SNS levels were not related to suicidality[44,45]. Notably, in both studies current or past history of alcohol/substance abuse was an exclusion criterion. This could have bias the results in that the excluded abusing patients would be expected to have higher SNS levels. More recently, suicide attempts were examined as one of the objectives of the study of Miralles et al[59] described in Table 7. Similarly to the aforementioned reports, no correlation of SNS with the number of suicide attempts was found, but importantly in this study, patients with a history of alcohol/substance abuse were not excluded. These results are in line with previous research which suggested that NS scores were not correlated with suicide attempts in psychiatric in-patients with several non-psychotic disorders[65].

Regarding the impact of SNS on psychopathology, most studies[23,26-28] revealed no association. Some research however has inconsistently suggested a correlation with psychotic symptoms, poor insight and executive dysfunction[22,24,26]. These results need replication to determine whether SNS is implicated in the symptomatology of psychotic disorders, and if so what are the exact neurobiologic pathways of such a correlation. Research on the association of SNS with measures of subjective quality of life yielded mixed results, but most studies do not support any correlation. Interestingly, in the study of Miralles et al[59] NS was found to be positively correlated with the number of admissions to a psychiatric hospital in male patients.

It is generally believed that schizophrenia patients have a unique personality profile as estimated with the use of different personality models[66]. Regarding studies using Cloninger’s temperament and character model several personality dimensions have been found to be altered in schizophrenia[57]. However, it is unclear whether SNS levels differ in psychotic patients as a group, compared to healthy individuals. Some studies (see Tables 1, 3 and 7) suggest that SNS is lower in psychotic patients, whereas most (see Tables 1, 3, 6 and 7) yield no differences. The meta-analysis by Ohi et al[57] showed no differences in European populations, but significant lower levels of SNS in Asian subjects. Overall, this trait was not different in patients and controls, but there was heterogeneity among studies. A previous meta-analysis suggested...
that the overall level of NS was lower among individuals with schizophrenia compared with controls, but the difference was not statistically significant [61]. It should be noted however that in many studies a history of alcohol and/or substance abuse was an exclusion criterion. Given the high rates of abuse in schizophrenia patients this means that a large proportion of patients who probably had higher SNS levels were excluded from research. Conceivably, this might have biased the results and may explain the reported lower SNS levels in the patient population.

It might be argued that schizophrenia patients as a group have SNS levels comparable to healthy persons. It appears that SNS does not increase the risk of schizophrenia and thus it may not be a potential endophenotype of schizophrenia, in contrast to other temperamental components, such as harm avoidance, as supported by several studies involving patients, siblings and other first-degree relatives [54,55,58]. Notably, some researchers have argued that healthy controls participating in research protocols and been recruited via advertisements in the media may be those with the higher SNS levels among the healthy population [54]. According to the definition of SNS it is not clear how participating in these procedures would be such an exciting experience for the supposed high SNS individuals. However, if this is the case of research healthy participants, and bearing in mind that in several studies patients with the higher SNS levels (who are more likely to be abusing patients) are excluded, it is an intriguing question whether psychotic patients may in fact have higher levels of SNS than the general population. However, this is not supported by the few studies in which alcohol/substance abuse was not an exclusion criterion (see Tables 1, 6 and 7), and showed patients’ SNS levels to be equal or lower [41] than controls. Evidence from the study of schizophrenia patients with the application of other personality models, such as the Costa and McCrae Five Factor model, also suggests that Openness to experiences levels (a concept close related to SNS) are lower in schizophrenia patients compared with healthy controls [67]. Future research should not exclude dual diagnosis patients to clarify this issue.

From a methodological perspective, it could be argued that all studies have used self-report personality assessments, which are not objective. However, research has shown that personality domains can be reliably measured with self-report instruments and results are easy to obtain [57,68], which renders such assessments relevant for clinical use.

This study has some limitations. The search was limited only to a single database (PubMed) and this may mean that several relevant studies included in other databases may have been missed. Another limitation is that the search was restricted to English-language articles, and studies in other languages were omitted.

CONCLUSION

Although personality traits may not be easily amenable to modification, it is important for clinicians to acknowledge and take into account such patients’ characteristics when planning and releasing treatment formulations. The evaluation of SNS may thus be an important part of clinical examination, and should be routinely performed. This trait can be reliably measured with the use of easily applicable self-rated instruments, and patients’ accounts could inform clinical practice and should be taken into account by clinicians when planning management and delivering individualized treatment.

It is proposed that practicing clinicians should regularly inquire for SNS when assessing patients’ personality as integrated part of the diagnostic workup. The clinical relevance of exploring SNS trait in subjects with severe psychiatric disorders is that it would help to identify patients prone to substance abuse or to medication non-adherence and perhaps violent behavior. This would facilitate the implementation of trait-specific interventions, when available.

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