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Substance Abuse Treatment, Prevention, and Policy

REVIEW

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The repeatable battery for the assessment of neuropsychological status (RBANS) and substance use disorders: a systematic review

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Abstract

Background Cognitive deficits are prevalent among substance use disorder (SUD) patients and affect treatment retention and outcome. The Repeatable Battery for the Assessment of Neuropsychological Status (RBANS) is a well-researched instrument in diverse patient groups and has the potential to serve as an effective and accurate method for identifying cognitive impairment in SUD patients. This systematic review examines the RBANS' ability to detect cognitive impairment in SUD patients. Limitations of knowledge and the need for further research are discussed.

Methods We conducted a systematic search using PsycINFO, Medline, and Cochrane databases to identify relevant studies and articles on applying RBANS in SUD. No time limits were imposed on the search. Search words were RBANS, substance use disorder, drug use disorder, and alcohol use disorder, and the most common specific types of drugs (e.g., opiates, cannabis, and methamphetamine).

Results A systematic search identified 232 articles, of which 17 were found eligible and included in the review. Most studies examined patient groups using either alcohol, methamphetamine, or opioids. The results are presented in the form of a narrative review. We identified some evidence that the RBANS can detect group differences between SUD patients and healthy controls, but the findings were somewhat inconsistent. The literature search revealed little information about cognitive profiles, reliability, factor structure, and construct and criterion validity.

Conclusions The evidence concerning the validity and usefulness of the RBANS in SUD populations is scarce. Future research should investigate cognitive profiles, reliability, factor structure, and construct and criterion validity.

Keywords RBANS, Cognitive screening, Cognitive impairment, Alcohol, Substance use disorder

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Introduction

The association between neuropsychological impairment and substance use disorder (SUD) is well documented, with an estimated prevalence of cognitive impairment (CI) in 20–80% of SUD patients [1–4]. Deficits in episodic memory, attention, executive functions, and decision-making are common [4–6]. In particular, executive functioning (EF), including the abilities of reasoning, planning, and problem solving, has been shown to be impaired in patients with SUD [7, 8]. Impairments may be transient or chronic and vary between mild to moderate and severe, depending on the types of substances used and quantity and frequency of use [2, 9]. Consequently, there is notable heterogeneity in the severity and pattern of specific impairments within this population [10].

CI has been linked to problems in everyday functioning, poor attendance and discontinuation of treatment, lack of motivation for change, not engaging in therapeutic activities, and reduced ability to take advantage of and apply therapeutic interventions to make desired changes [6, 11–14]. Most empirically supported SUD treatments require attentional efforts, the ability to process information, the ability to formulate and understand ideas and concepts, and finally, to remember and recall the information presented in treatment [3, 9, 10]. Consequently, CI can affect the patient's ability to engage in and benefit from therapeutic interventions. Further, without special rehabilitation efforts, CI limits the possibility of being integrated into the ordinary workforce [15]. On the positive side, research findings indicate that different cognitive remediation approaches may effectively ameliorate CI [10]. Thus, accurate and timely detection of CI is vital [16]. However, clinicians may overrate their ability to assess cognitive functioning based on clinical observation and, therefore, overestimate the patient's cognitive capacity [17]. This may result in a lack of treatment adjustment to the patient's level of functioning, impairing the treatment effect.

Clinical guidelines often recommend that cognitive function is assessed when an individual presents for treatment in SUD specialist treatment services [e.g., 18]. As a result, CI should ideally be routinely examined in specialized SUD treatment clinics, but time constraints, staff shortages, and lack of neuropsychological expertise often do not permit comprehensive assessments [16]. These are complex, time-consuming, and require specialist competence. Thus, cognitive screening is a critical first stage in the assessment process to detect those who need a more comprehensive neuropsychological assessment [19]. To secure adequate screening of SUD patients, a recent review concludes that more research and more robust methodological designs are needed as current studies on screening tools are limited in number and quality [16].

Ko et al. [16] identified ten unique cognitive screening tools and found that the Montreal Cognitive Assessment (MoCA) [20] might be an effective screening tool with adequate sensitivity and specificity, that the Mini-Mental State Examination (MMSE; [21] cannot be recommended for this patient population, and that some newly constructed tools (i.e., Brief Evaluation of Alcohol-Related Neuropsychological Impairments [BEARNI] [22] and Brief Executive Function Assessment Tool [BEAT] [23]) are promising but need further validation. However, for some reason, Ko et al. [16] did not include studies assessing the usefulness of the Repeatable Battery for the Assessment of Neuropsychological Status (RBANS) [24, 25] in SUD patients.

The RBANS is an up-to-date neuropsychological battery with known psychometric properties and does not require specialist competence [25, 26]. It is the 11th most-used screening test worldwide [27]. In the Nordic countries, 10.7% of neuropsychologists use the RBANS, and among the ones who use it, 31.8% apply it as part of a standard assessment battery [28]. Whether the RBANS should be considered a screening tool or a neuropsychological test battery is open to discussion. According to the author, it was developed as a stand-alone core battery for detecting dementia in older individuals and a screening battery when lengthy assessments are impractical and/or inappropriate [24]. However, using RBANS as a stand-alone assessment is a topic of debate [29].

The RBANS takes about 20 min to administer and uses twelve subtests to yield five index scores measuring attention, verbal and visuospatial skills, immediate and delayed memory, and a total score measuring general cognitive functioning and/or impairment. As CI in SUD is heterogeneous, the RBANS has the potential to be a viable screening instrument within this group as it examines a range of cognitive functions. The RBANS is a more diverse and complex test than, for example, the MoCA [3].

Initially, the RBANS did not have a specific executive scale or index [30, 31]. Because impairments in EF are important in understanding SUD [8, 32, 33], this could suggest that RBANS might not be the most appropriate screening tool to detect SUD-related cognitive deficits. However, studies using comprehensive test batteries generally report cognitive impairments across a broad range of cognitive domains in SUD populations [34, 35], and measures of general cognitive abilities have been shown to be better in distinguishing between patients with SUD and controls compared to performance-based tests on EF [7]. This suggests that screening and assessment of cognitive impairment in SUD should include a broad range of functions. Moreover, a specific RBANS scale of EF has been developed, the RBANS Executive Errors scale (EE) [31]. The RBANS EE can prove helpful when assessing persons with SUD, but the scale's psychometric properties have not been examined in this patient group.

RBANS includes several forms to reduce practice effects for repeated administrations; for example, four forms are available in English, and two forms exist for the Spanish and Danish, Norwegian, and Swedish versions. This allows clinicians to evaluate neuropsychological functioning over time, which is especially important in SUD treatment, where cognitive deficits are assumed to vary in response to the length of time the patient has been abstinent and the amount of drug use before entering treatment [4].

On the one hand, because the RBANS is time-efficient, provides a multiscale profile of cognitive function, and allows for retesting, it should have the potential for use in SUD samples. On the other hand, it was not developed for this population. Gradwohl et al. (2023) emphasize that executive dysfunction may vary between clinical groups. Similarly, certain instruments, for example, proven sensitive to evaluate CI in dementia or brain disorders [36, 20], may not be sufficiently sensitive in other populations. Thus, before recommending that clinicians use the RBANS in assessing SUD patients, a comprehensive review of the relevant published research is warranted to summarize the existing evidence. Therefore, we attempt to review the evidence on the viability of the RBANS when used with individuals with SUD to inform clinicians and researchers of the strengths and limitations of the RBANS within this population. In the following, we present a narrative review and a call for increased research attention on RBANS and SUD. Our aims are:

1) Review the evidence for the ability of the RBANS to detect cognitive impairments in individuals with SUD.

2) Report knowledge gaps related to RBANS assessment and cognitive impairments in individuals with SUD and identify avenues for future research.

Methods

Search strategy

Articles were identified through searches for peer-reviewed publications in PsycINFO, Medline, and Cochrane databases. We searched subject headings (e.g., MeSH terms), keywords, and keyword phrases. The search contained the following terms: Repeatable battery for the assessment of neuropsychological status OR RBANS, AND substance use OR drug use disorder. In addition, we included search terms for specific substances, e.g., alcohol* OR cannabis* OR heroin* OR cocaine* OR amphetamine* OR hallucinogen* OR medication* OR medicine* or opioid* or opiate*. No time limits were imposed on the search. See Appendix 1 for the complete search strategy. This search yielded a total of 165 articles eligible for title and abstract screening after removing duplicates (See Appendix 2 for PRISMA flow chart).

Because of the small number of records found, and to ensure that the search syntax detected all relevant articles, we performed a new search in the same databases, using only the terms Repeatable Battery for the assessment of neuropsychological status OR RBANS. The RBANS was published in 1998, so this was the natural time limit for the search. After removing duplicates, the search yielded 1187 records. We screened the records, but this broader search yielded no articles besides the original search on RBANS and substance use. In addition, we hand-searched reference lists and citations in relevant articles and books. This resulted in one additional finding [37]. The original search was updated on 29.04.24 and detected two additional articles.

Inclusion and exclusion criteria

One author screened the articles. Two authors did the full-text review and extraction of papers.

We applied the following inclusion criteria:

1. Observational or randomized controlled studies.
2. Peer-revied, published reports.
3. English language.
4. Populations with substance use disorder, alcohol use disorder, or heavy drinking.
5. Participants being adults (18 years or older).
6. Reporting test scores from the full RBANS battery.

Exclusion criteria:

1. Case studies or study protocols.
2. Individuals under the age of 18.
3. Studies on individuals with psychotic disorders were excluded as this group is usually not treated in SUD treatment facilities.
4. Nicotine or caffeine use disorders.
5. Incomplete RBANS battery/studies only including subtests.

The majority of records were excluded because they did not address populations with substance use disorders. One potentially eligible study [38] was excluded because it did not apply the full RBANS battery. Finally, 17 articles were included in the review.

We were mainly concerned with identifying test scores, studies on SUD with comparison groups, factor analyses, studies on diagnostic accuracy, and other reliability and validity indices of the RBANS in SUD populations. As a result, we do not discuss other research questions and findings in some of the studies. Scores were considered impaired if they were one standard deviation (SD)

Table 1 Summary of reports

Reference	Location	Age(SD)	Subgroups - cases	Total *N* cases	Male/ female(*n*)	Control *N*(Age/SD)	Study design	Treatment level	Key findings
ALCOHOL									
1. Brown et al. (2019)	Scotland	46.1(8.9) 56.9(7.2)	AUD-only Alcohol-related brain damage	58	37/21	-	Cross-sectional	Community/hospital	• Patients with ARBD more impaired (i.e., <2nd percentile) RBANS than AUD-patients without ARBD • RBANS superior to ACE-III as a screening instrument in AUD-populations
2. Cao et al. (2021)	China	42.0(7.6)	-	60	60/0	40(42.0/6.6)	Case-control	Inpatients	• AUD group significantly lower scores in Immediate Memory, Attention, Language, and Delayed Memory • Associations between ERPs and RBANS scores
3. Green et al. (2010)	Australia	58.0(17.0)	-	28	21/7	28 (57.0/17.0)	Case-control	Community	• Drinkers (moderate to heavy alcohol use) performed below the control group on the Visuospatial and Memory index and RBANS total score. • Drinkers greater decline in RBANS scores from estimated cross-sectional premorbid levels
4. C. Liu et al. (2020)	China	44.4(5.2) 41.28(5.2)	Patients with AUD and aggressive behavior Patients with AUD without aggressive behavior	80	80/0	40 (49.9/4.9)	Case-control	Inpatients	• Patients with AUD and aggressive behavior significantly lower scores on Immediate Memory and Attention compared to other patients and healthy controls • RBANS Immediate Memory and Delayed Memory lower in both groups compared to healthy controls
5. Y. Liu et al. (2021)	China	45.5(14.0)	-	26	26/0	53(41.5/9.4)	Case-control	Inpatients	• Patients with AUD lower scores across all RBANS subscales and RBANS Total Score
6. Mulhauser et al. (2018)	USA	21–65	-	28	27/1	-	Prospective	Inpatients	• All participants clinically impaired at treatment entry • 73% had cognitive impairments after ten days
METHAMPHETAMINE									
7. Chen et al. (2022)	China	33.3(7.0)	-	330	330/0	140(32.1/8.9)	Case-control	Inpatients	• Cases performed worse on all RBANS' index scores compared to healthy controls • Patients with methamphetamine dependence and childhood abuse had more scores indicating impairment (i.e., <5th percentile) than patients without maltreatment in childhood
8. He et al. (2022)	China	35.7(5.4) 35.9(6.3) 35.4(5.7)	Low resilience group Medium resilience group High resilience group	134	134/0	-	Cross-sectional	Inpatients	• Lower resilience was associated with lower RBANS' scores • Patients with methamphetamine dependence with low resilience significantly lower RBANS Total Score being in the impaired range (i.e., <5th percentile)

Table 1 (continued)

Reference	Location	Age(SD)	Subgroups - cases	Total *N* cases	Male/ female(*n*)	Control *N*(Age/SD)	Study design	Treatment level	Key findings
9. Jiang et al. (2022)	China	34.2(7.1) 34.0(7.1)	With PTSD Without PTSD	464	464/0	156(33.2/9.0)	Case-control	Inpatients	• Cases had lower scores on all RBANS' index scores and Total Score • Comorbid PTSD not associated with more severe cognitive impairment
10. Su et al. (2015)	China	31.5(8.4)		194	160/34	378(46.0/13.0)	Case-control	Inpatients	• Cases had lower scores on the Immediate Memory, Language, and Delayed Memory index • Cases had higher scores than controls on the Visuo-spatial index
11. Tian et al. (2022)	China	34.2(7.1) 45.8(5.7)	Methamphetamine use disorder Heroin use disorder	654	654/0	201(30.3/9.6)	Case-control	Inpatients	• Patients with methamphetamine and heroin use disorder significantly lower scores on all RBANS indices and total score • Patients with methamphetamine disorder significantly lower scores on the Delayed Memory index compared to patients using heroin
12. Zhao et al. (2020)	China	30–43		106	106/0	76(30–47)	Case-control	Inpatients	• Cases had significantly lower scores on all RBANS index scores and Total Score
OPIOIDS									
13. Luan et al. (2017)	China	35.1(8.0)		86	77/9	238(47.9/12.5)	Case-control	Inpatients	• Cases had significantly lower scores on the Attention and Language index
POLYSUBSTANCE SAMPLES									
14. Dong et al. (2023)	China	49.4(1.9) 50.0(5.4)	rTMS iTBS Control group: persons polysubstance use disorder	38	31/7	16(48.8/6.3)$_p$	Prospective	Inpatients	• In a pre-post design, transcranial magnetic stimulation (iTBS and rTBS) improved RBANS' Total Score, Immediate Memory, and Attention. • Cases and sham group had impaired RBANS Total Score at baseline
15. Kutash et al. (2023)	USA	35.6(10.2) 34.2(10.6)	Patients with SUD Patients with SUD and PTSD	128	85/43	-	Cross-sectional	Inpatients	• RBANS Total Score impaired in both the SUD and SUD with PTSD group • The correlation between RBANS and MoCA was weaker in the patients with SUD and PTSD (r=.32) than in patients with only SUD (r=.56)

Table 1 (continued)

Reference	Location	Age(SD)	Subgroups - cases	Total *N* cases	Male/ female(*n*)	Control *N*(Age/SD)	Study design	Treatment level	Key findings
16. Ridley et al. (2018)	Australia	52.3(10.4)		30	18/12	20	Cross-sectional	Outpatients	• 20–37% of patients had impaired scores on all the RBANS' indices except the Language index • Total score on MoCA and ACE-R were strongly related to the RBANS' total score • Less clear findings for associations between domain scores and indices
17. Schrimsher & Parker (2008)	USA	47.8(8.6)		58	54/4	-	Prospective	Daycare/inpatients	• RBANS Total Score impaired at treatment entry and completion • Significant improvement in Immediate Memory, Attention and Total score

Age: When age(SD) was not reported in papers, the age-range for cases is reported in the summary. Subgroups - cases: Column includes information on subgroups of cases in the study

or more below the normative mean [39]. Applying this definition ensures that mild CI to more severe manifestations were considered, as even mild CI is associated with mental disorders, SUD, and poor everyday functioning (e.g., 40].

We contacted the corresponding authors twice in two separate instances because we believed the reports might have originated from the same patient sample and study. One author responded, resolving the issue.

Risk of bias

Methodological quality and risk of bias were assessed using the Critical Appraisal Skills Programme (CASP) [41]. As the studies reviewed encompassed several different research designs, the appropriate checklist was chosen based on the study design. Results are shown in Appendix 3. Due to the limited number of articles, we presented the findings as a narrative review.

Below, we first review evidence on studies on different SUDs with comparison groups. Then, we examine longitudinal studies, other groups of interest, and issues related to diagnostic accuracy and validity. Lastly, we discuss gaps in knowledge and directions for future research. Table 1 summarizes the study designs, number of participants, and key findings.

Results

Studies with comparison group

The studies identified were mainly concerned with alcohol, methamphetamine, and opioids, comparing individuals with SUD and healthy control groups. A summary of results on RBANS indices is provided in Table 2.

Alcohol

We identified three reports that compared the RBANS scores of individuals with a diagnosis of AUD and one study of moderate to heavy drinkers with a healthy control group. Two reports originate from the same study [42, 43], and they did report all index scores but not an RBANS Total Scale score. The other two reported lower Total Scale scores than controls [44, 45]. Green et al. [44] did not include persons diagnosed with AUD but drinkers with moderate to heavy alcohol use. All four articles reported lower performance on Immediate Memory compared to the control group, while two of four reported reduced visuospatial and language functions, respectively. Three out of four articles reported lower scores on Attention and Delayed Memory. Although the AUD group, as a rule, scored lower compared to healthy controls, it should be noted that AUD patients' mean test scores were in many instances firmly in the average range (i.e., index scores between 90 and 109) and thus not indicative of cognitive impairment (i.e., at least < 1 SD below normative means).

Table 2 Overview of RBANS' index scores and total scores significantly lower in SUD-patients compared to healthy control groups

	Immediate				Delayed	
Reference	**Memory**	**Visuospatial**	**Language**	**Attention**	**Memory**	**Total Scale**
ALCOHOL						
Cao et al. (2021)	x	0	x	x	x	—
Green et al. (2010)	x	x	0	0	0	x
C. Liu et al. 2020)[z,2]	x	0	0	x	x	—
Y. Liu et al. (2021)	x	x	x	x	x	x
METHAMPHETAMINE						
Chen et al. (2020)	x	x	x	x	x	x[2]
Jiang et al. (2022)	x	x	x	x	x	x
Su et al. (2015)	x	0	x	x	x	0
Tian et al. (2022)	x	x	x	x	x	x
Zhao et al. (2020)	x	x	x	x	x	x
HEROIN						
Tian et al. (2022)	x	x	x	x	x	x
Luan et al. (2017)	0	0	x	x	0	0

x = SUD group had significantly lower scores than the control group. 0 = no significant differences between SUD and control group.- = not reported. Results reported for patients with AUD and aggressive behavior. [2] Total Scale reported for patients with methamphetamine use disorder and childhood maltreatment

Taken together, the results show a small number of reports where one sample could be classified as near the impaired range, with an average RBANS Total Score of 86.92 in the alcohol dependence group [45]. There were two negative and two positive findings regarding visuospatial and language impairment, respectively. These two cognitive measures are somewhat higher in many, but not all, clinical groups [26, 36, 46, 47] compared to the other cognitive domains measured with the RBANS. Thus, a less clear finding here may reflect a genuine difference between samples.

Methamphetamine

We identified five studies reporting on the use of the RBANS with patients with methamphetamine use disorder [48–52]. After reviewing the published papers, it appears that three of them may be from the same study. However, we have been unable to confirm this with the authors [48, 49].

Including the three reports probably emanating from the same sample, two out of three samples showed a significantly lower Total Score on the RBANS than healthy controls. Two of the three samples had low scores on visuospatial ability. At the same time, the reports uniformly found the Immediate Memory, Language, Attention, and Delayed Memory indices to be significantly lower than those of the control group.

Heroin and opioids

Only two reports examined the use of the RBANS by comparing heroin use disorder patients with controls [53, 54]. One report found that patients with heroin dependence had lower scores on all RBANS indices and Total Scale scores. Both reports observed lower scores on the Language and Attention index scores.

Other studies of RBANS and substance use

One article examined sub-groups within the AUD patient group. The first examined patients with AUD, with and without aggressive behavior. The authors found that the patients with AUD with aggressive behavior had significantly lower scores on Immediate Memory and Attention indices than non-aggressive patients with AUD and the control group [43]. However, patients with AUD and non-aggressive behavior also had more deficits in cognitive functioning than the control group.

One study investigated the association between resilience, impulsivity, and cognitive function in patients with methamphetamine dependence [55]. Low levels of resilience were associated with more CI, while patients with high levels of resilience had higher scores on the RBANS. A significant difference in Total Score between the low, medium, and high resilience groups was detected, and the low resilience group was firmly in the impaired range (i.e., <5th percentile).

Changes in cognitive function over time

Two studies analyzed changes before and after the completion of a detoxification program. In the first study, a group of patients with SUD in a residential/day treatment program was examined with the RBANS at intake and after three weeks of abstinence [56]. The authors found a significant change with medium effect sizes in Immediate Memory, Attention, and Total Scale scores from treatment entry to treatment completion after three weeks. Furthermore, patients with the lowest levels of cognitive performance at treatment entry demonstrated more improvement compared to the higher-performing patients.

Mulhauser et al. [57] analyzed changes in neuropsychological functioning in patients with AUD during detoxification. Assessments were conducted at treatment entry and after ten days. They reported significant changes in Immediate Memory, Visuospatial, and Total Scores from time one to time two. 93% of the patients were classified as clinically impaired at treatment entry, and 73% were clinically impaired in at least one domain ten days after detoxification.

In a study examining the effect of transcranial magnetic stimulation in treating patients with polysubstance use [58], the authors compared the RBANS scores of three groups: two intervention groups and one sham-control group. They detected a difference in cognitive functioning in both intervention groups as measured by the RBANS but no significant difference in the sham control group. By comparing patients with polysubstance use scores with Scandinavian normative data, performance on the RBANS Total Score corresponded to the 7-9th percentiles, and the Visuospatial and Immediate Memory indices were at the 5th percentile.

Classification accuracy and validity

Our search did not identify any studies applying the RBANS and comparing it to a reference test battery. However, we identified four studies using the RBANS in comparison studies or studies validating other methods.

One study compared the RBANS with another screening test for cognitive impairment, while another compared RBANS results with established brain-related criteria of cognitive function. The first [59] compared the suitability of the RBANS with Addenbrooke's Cognitive Examination (ACE-III). Patients with AUD and alcohol-related brain damage (Korsakoff's and other alcohol-related disorders) were compared with unimpaired patients with AUD. Both instruments proved useful tools for cognitive screening, but the RBANS was superior in detecting cognitive impairment.

Cao et al. [42] used the RBANS and event-related potentials (ERP) to evaluate patients with AUD degree of cognitive impairment compared with healthy controls, as abnormalities in ERP could be a specific neuropsychological trait marker in patients with AUD. As displayed in Table 2, they found that Immediate Memory, Language, Attention, and Delayed Memory were impaired. While the present review aims to examine the validity of the RBANS, Cao and colleagues [42], conclude the other way around, noting that the correlations between the RBANS and ERPs suggest that ERPs may serve as an objective basis in the assessment of cognitive functions. Furthermore, this study uses unconventional terms for the RBANS measures (e.g., "visual breadth"). It is unclear which tests are included in those measures, making comparisons with other studies difficult.

Two studies have included RBANS in the reference test battery when examining the accuracy of other screening instruments. Ridley et al. [37] investigated the diagnostic accuracy of MMSE, ACE-R, and MoCA, using the RBANS and five tests of EF as a reference test battery. The authors applied impairment criteria of scores 1.5 SD or more under the mean on any of the RBANS indices (omitting the Total Scale) or scores that fell 1.5 or more SD below normative means on at least two of the EF reference tests. In total, 67% of the SUD group was classified as impaired on the entire reference battery compared to the MoCA, which classified 63% as impaired, the highest rate of the three instruments. The EF tests of reference battery classified 23% as impaired. No percentage of the RBANS is reported, nor was the overlap between the EF reference tests and the RBANS in classifying impairment. Consequently, the range of the RBANS is between 44% (no overlap) to 67% (full overlap).

A recent study by Kutash et al. [60] used RBANS as a reference when examining the predictive validity of the MoCA in detecting cognitive impairments in patients with only SUD and a group with SUD and PTSD. Compared to normative data, the SUD group had scores of 1 SD or more under normative means on mmediate memory and delayed memory. The Visuospatial index was just within the low average, with a mean score of 86. The percentage of scores ≤ 5th percentile ranged between 11.8% (i.e., Language Index) and 31.4% (i.e., Immediate Memory and Visuospatial indices). The group with SUD and PTSD had scores of 1 SD or more below the mean on the Visuospatial index and Delayed memory. The percentage of scores ≤ 5th percentile ranged between 13.0% (i.e., Immediate Memory Index) and 31.2% (i.e., Visuospatial index). However, the MoCA and RBANS were not highly correlated, and the MoCA was especially poor in detecting CI in patients with SUD and PTSD. The authors do not discuss how they judge the performance of the RBANS in relation to MoCA or whether they would recommend using the RBANS instead of MoCA in SUD populations.

Discussion

Summary

After reviewing the existing research on the RBANS and SUD, we conclude that there is a lack of research on most aspects of the use of the RBANS in SUD populations, particularly its usefulness and accuracy as a screening instrument. The following discussion will consider strengths and limitations in the research evidence concerning the RBANS and SUD and outline areas for future investigation.

The ability of RBANS to detect cognitive impairment in SUD

Currently, the limited number of studies and mixed findings preclude clear conclusions regarding the usefulness of the RBANS as a screening instrument for patients with

AUD. The four studies reviewed report lower Immediate Memory scores, reflecting the general findings regarding memory in AUD [14]. Regarding attention and delayed memory, there are mixed findings that leave the question open as to the sensitivity of the RBANS. A tentative conclusion is that the RBANS might not be sufficiently sensitive to subtle impairments in verbal or visual functions, as such impairments are documented in studies using more extended testing [4]. Less complex tasks may be less sensitive to subtle abnormalities than tests using more complex tasks [6, 61]. In addition, tests not developed for AUD populations may not target the actual impaired domains in AUD [62].

The results from studies on patients with methamphetamine use disorder seem to converge, and these patients appear to be impaired on most if not all, RBANS index scores compared to controls. Because of the limited number of studies, the findings concerning RBANS and cognitive impairment in patients with heroin use are inconclusive.

Most studies comparing the RBANS scores of SUD patients with healthy control subjects have observed that SUD patients had lower scores than healthy controls. This result is not surprising, as it is well documented in the research literature that many SUD patients experience cognitive deficits. However, it does indicate that the RBANS can reliably detect cognitive deficits in patients with SUD.

Knowledge gaps and methodological concerns

To establish the diagnostic accuracy of a screening instrument in detecting CI, it is essential to compare the screening instrument to an objective reference standard. The reference standard is usually a well-established test battery or collection of tests. However, no single test battery or collection of tests is established as a gold standard in neuropsychological research on SUD in general, and the field has applied a variety of reference test batteries to investigate accuracy and validity [16]. The sensitivity and specificity of the test batteries, though well-proven in other patient samples, are often unknown in SUD samples.

Further, there are several other challenges related to the use of criterion or reference tests when examining the validity of a measure or test. For example, the administration of the index and the reference tests should ideally be blinded or not performed by the same administrator to avoid bias in administration and scoring, and many studies have not paid enough attention to the timing and flow of administrations [16]. As such, there are methodological limitations related to all research on SUD and cognitive screening instruments at this stage. However, studies of different clinical groups (e.g., traumatic brain injury, stroke, Parkinson's, and Alzheimer's disease) have shown that the RBANS indices have strong correlations with comparable neuropsychological tests and are primarily equivalent in sensitivity and specificity in discriminating between cognitively impaired and nonimpaired neurological patients [63–65].

Nonetheless, this review finds that no studies have used the RBANS and a more extensive test battery to verify the consistency in findings in SUD populations. Conversely, two studies have used RBANS as a reference battery to examine the accuracy of other screening instruments [37, 60]. For our purposes, it is possible to draw one conclusion from these studies: The RBANS performs better in detecting CI than other brief screening instruments it has been compared to in SUD populations. In the Cao et al. [42] study, the validity of the RBANS is taken for granted, and instead, the test battery is used to validate the use of ERP. Thus, the question posed in the review of studies on AUD—whether the finding that only half of the studies showed lower visuospatial and language scores in the AUD group compared with controls reflects insufficient sensitivity of the RBANS or a genuine finding—could not be answered. The fact that no studies have investigated the criterion validity of the RBANS in SUD populations points to a lack of knowledge on an essential point regarding test validity.

Some studies had an uneven distribution of participants in the case and control groups, which might be a methodological limitation. A related issue is the unbalanced proportion of men and women in studies, as there is some evidence of gender differences in RBANS test performance [26]. Eight of the reports reviewed examined male-only populations, and most other studies had a clear imbalance between men and women, a situation similar to other research on SUD [66]. Thus, the results may not be automatically generalized to women with SUD.

In line with applying the RBANS as a neuropsychological screening, most studies reviewed here report index and total scores. However, there is some variety concerning the reporting of scores, as at least one study probably reports raw scores [42]. Future research should specify both the type of scores reported and preferably report the same type of scores, as this simplifies cross-study comparisons. Relatedly, researchers should use the terms for the index scores specified in the manual when reporting results, as using other terms may confuse readers (i.e., Cao et al., 2021).

As noted in the introduction, an EF scale, the RBANS EE, has been developed, allowing clinicians to quantify executive errors. However, there are currently no studies applying this scale in SUD samples. Thus, the use of the EE scale in place of other well-validated tests of executive functioning is presently not supported [31]. The RBANS EE can be used as an aid in the assessment of EF, but the scores should not be used in isolation in clinical assessments [30, 31].

We did not identify any studies that analyzed the invariance of the factor structure of the RBANS, i.e., whether grouping the 12 separate tests into five index scores reflecting different cognitive domains is also valid for the SUD patient group. Whether these five cognitive domains are relevant in SUD is an empirical question that must be examined in factor analyses. If the 12 tasks load on smaller or larger or different factors (i.e., indices) among patients with SUD, this will affect the validity of the standard five-factor model applied in most studies. In addition, few of the studies reviewed here report the mean test scores on all twelve subtests and instead report index scores based on a yet not proven factor structure.

The factor structure of the RBANS is theoretically derived, and results from factor analytic studies on other patient populations are mixed. A literature review identified support for a two, three, and five-factor structure depending on the clinical composition of the samples [67], and a meta-analysis in the same article found support for the five-factor structure. To be useful in clinical practice with SUD patients, the clinician needs to be sure that the different subtests load on the assumed underlying variables for this patient group. Subtests intended to measure a particular concept might measure something else in samples of patients differing from the normative sample, as when a test intended to measure attention demands knowledge as well. In this situation, the test may function as a test of verbal abilities among subjects with less education. Another example is digit span, considered a test of attention in the RBANS, which is often found to reflect risk of dyslexia [68]. Such inconsistencies in factor structure may contribute to misclassification of the type of cognitive deficit. As long as the factor structure is not confirmed in this patient group, clinicians are advised to merely interpret the test's total score or separate test scores instead [69].

There are also implications concerning clinical practice, particularly related to the administration time of screening tools or tests. While the RBANS only takes about 20 min to administer, clinicians who work in busy settings are often overloaded with clinical tasks. However, even the MoCA takes around 15 min to administer, which is not significantly different from the administration time of the RBANS. In the absence of evidence-based guidelines on screening tools for the SUD population [16], the advantage of using a more comprehensive screening battery, like the RBANS, is that it may reduce the risk of false positives. If a screening test is time-efficient but yields many false positives, it can result in excessive referrals for full neuropsychological assessments and not prove to be time-saving after all [35]. Clinicians could profit more from using a comprehensive instrument from the outset.

Limitations

This review has the following limitations. The body of literature was small, and there were overlapping samples. Therefore, we decided to include and review all studies captured by the search, regardless of methodological details, to provide the reader with the complete picture of RBANS and SUD. Nonetheless, the limited literature on the subject necessarily makes some of the conclusions tentative.

However, we did conduct a critical appraisal of the studies to assess the risk of bias and the robustness of our narrative synthesis (see Appendix 3). Overall, most of the studies had clear methodological concerns, primarily related to the representativeness of the samples, sample size, and significant differences in sizes between comparison groups. Few of the studies had conducted a power analysis ahead of the study. Furthermore, most of the studies did not control confounding factors adequately, limiting the validity of the findings. The groups studied were not always clearly defined, and in many studies, substance use during the study period was not controlled for. A more extensive recording of history of substance use, frequency of substance use, and objective measures beyond self-report, could have been beneficial. Relatedly, key features of study design and administration and timing of measures were not adequately described or omitted in many studies.

As already noted, many studies examined only men, which affected the generalizability of the results. Due to the study design, which was mainly cross-sectional, most studies examined associations between variables, resulting in limited possibilities for drawing causal inferences. Finally, even the two studies considered methodologically sound had minor concerns concerning sample composition, which limit the generalizability of their results. On the positive side, most studies acknowledged at least some of their limitations and discussed them in an appropriate manner.

Conclusion

The present review identified a limited number of reports about RBANS and its use in SUD populations. We identified some evidence that the RBANS could detect group differences between SUD patients and controls and changes in cognitive functioning over time. However, the literature search revealed little information about cognitive profiles, classification accuracy, and factor structure, and we discovered weaknesses in reporting results and study designs. Future research should investigate these areas to establish whether the RBANS is a useful screening instrument for clinicians working with SUD patients or researchers investigating cognitive functioning in SUD patients.

Abbreviations

ACE III	Addenbrooke's cognitive examination
AUD	Alcohol use disorder
BEARNI	Brief evaluation of alcohol-related neuropsychological impairments
BEAT	Brief executive function assessment tool
CI	Cognitive impairment
EF	Executive functioning
ERP	Event-related potential
MMSE	Mini-mental state examination
MoCA	Montreal cognitive assessment
PTSD	Post-traumatic stress disorder
RBANS	The repeatable battery for the assessment of neuropsychological status
SUD	Substance use disorder

Supplementary Information

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Supplementary Material 1

Supplementary Material 2

Supplementary Material 3

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Data availability

No datasets were generated or analysed during the current study.

Declarations

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Competing interests

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