International consensus for the assessment of social cognition in neurocognitive disorders: framework definition and clinical recommendations of the SIGNATURE initiative

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Abstract

BACKGROUND: Socio-cognitive assessment in neurocognitive disorders (NCDs) is rare in clinical practice and no consensus exists as to a uniform operationalization of socio-cognitive measures for neurocognitive disorders in memory clinics. The *SIGNATURE* initiative aims to optimize the use of socio-cognitive measures in memory clinics, defining expert recommendations. We report consortium guidelines for the use of socio-cognitive measures in NCDs based on available evidence from the literature and the current state of practices in memory clinics.

METHODS: Using a Delphi consensus method supported by a literature review and the results of an international survey, 22 specialists defined recommendations for the context of use, relevance in NCD diagnosis, priorities for future research and facilitators/obstacles of socio-cognitive assessment in major and mild NCDs.

RESULTS: Overall, panelists recommended social cognition testing in routine diagnostic assessment to evaluate both socio-cognitive and socio-behavioral alterations. A set of clinical, methodological, implementation and external factors facilitating or hampering the use of socio-cognitive tasks was identified.

CONCLUSIONS: This is the first focused endeavor to favor the implementation of socio-cognitive assessment, which is required by DSM-5 but seldom performed despite clear evidence of its clinical relevance for diagnosis and care. Our results provide an initial set of recommendations, refinable through the future actions of the *SIGNATURE* initiative. Future collaborative clinical research projects should overcome current limitations and foster the use of ecological and cross-culturally validated measures in clinics.

1. INTRODUCTION

Social cognition, which encompasses the cognitive processes underlying social interactions, is a critical domain affected in various neurocognitive disorders (NCDs), including Alzheimer's disease (AD) and related disorders (ADRD) [1]. Despite its recognized importance, assessment of the social cognition domain in clinical settings remains inconsistent and fragmented [2–5]. This variability hinders the ability to timely diagnose, monitor, and treat a considerable number of ADRD whose primary clinical profile differs from typical AD. Despite advancement in theoretical and clinical research, this knowledge has not effectively translated into improved expertise or familiarity with socio-cognitive assessments among clinicians in memory clinics, highlighting a persistent gap between research and clinical practice [6, 7]. To address these challenges, the *SIGNATURE* initiative was launched in 2022, aiming to systematize and optimize the use of social cognition measures across different international clinical centers (https://sites.google.com/unitn.it/signature-initiative/). The ultimate goal of the *SIGNATURE* initiative is to ensure that clinicians, regardless of their location or resources, have access to reliable and effective tools for assessing social cognition in case of cognitive and behavioral complaints associated with

suspected NCDs. In light of this, in 2022 we launched a survey to gather information on the state-of-art clinical practices and needs [8], laying the foundation for the next phase of the *SIGNATURE* initiative.

By providing clinical recommendations and suggestions on research priorities based on evidence from current literature and the state-of-the-art in clinics, the initiative seeks to promote consistency in clinical assessment, thereby improving the comparability of clinical research and findings across centers and the reliability of diagnoses. This ideally harmonized or at least consistent approach is expected to improve detection, patient care and care outcomes and to advance our understanding of social cognitive impairments in NCDs. The rationale for the *SIGNATURE* initiative is supported by analogous successful harmonization of socio-cognitive assessments in other clinical populations, such as autism spectrum disorders (ASD) and schizophrenia. Over 10 years ago, the “Social Cognition Psychometric Evaluation” (SCOPE) study was designed to identify not only the key dimensions of social cognition in schizophrenia but also the instruments best assessing these facets [9]. Alongside the growing understanding of social and non-social cognitive dysfunctions in this population [10], the SCOPE initiative has led to a set of cognitive assessment recommendations from the European Psychiatric Association, many of which focus on social cognition [11]. These recommendations aim to promote the use of standardized assessment protocols in both clinical trials and real-world clinical settings. Building from the experience of similar initiatives, applying standardized socio-cognitive assessments in NCDs holds significant promise. Ideally harmonized or at least consistent recommendations can enhance the early detection of social cognitive impairments, which are often present in the prodromal stages of NCDs [12]. Moreover, early identification can lead to timely interventions on patients and caregivers, which may slow the progression of the disease with positive outcomes on social functioning and quality of life.

This paper describes the establishment of a task force with the objective of defining a framework and formulating a preliminary set of clinical recommendations pertaining to the context of use and the current relevance of socio-cognitive testing in the dementia context. Additionally, it addresses the facilitators and obstacles to implementing this framework in clinical settings and suggests research priorities to support the development and implementation of social cognition assessment in NCDs.

2. MATERIALS AND METHODS

2.1 Task force

SIGNATURE Delphi team. The project task force included the Executive Board (EB), the Advisory Board (AB) and the panel (PA; details in Table 1). The EB included Delphi facilitators (C.C., A.D., G.F., C.M., A.P.) and one “external” reviewer (C.F.), one of the methodologists from the *SIGNATURE* initiative, who supervised the Delphi procedure. The AB included a scientific and methodological advisor (M.Bo.), 3 representatives from patient advocacy associations (L.I., M.P., M.T.) and an expert (M.T.) in neuropsychology practices in people with disabilities.

Delphi panelist. The panel consists of specialists from different countries and scientific societies, i.e., 10 neurologists and 12 psychologists/neuropsychologists (Table 1). Thirteen experts are clinicians with both research and clinical experience in socio-cognitive assessment in NCDs and nine are researchers with world-renowned expertise in social cognition. Nine experts are national collaborators (representatives of countries participating in the SIGNATURE initiative) and three are advisors (M.Be., F.K., J.VdS.) of the *SIGNATURE* initiative (see Participant section of the *SIGNATURE* website; https://sites.google.com/unitn.it/signature-initiative/participants). All have a long professional experience in NCDs and in the use of social cognitive tasks for diagnostic purposes in the clinical practice of their academic and high-level research institutions.

Table 1
Participants and roles at the first *SIGNATURE* workshop (September 2023).

Name, SURNAME	*Role in the Delphi Procedure*	*Role in the SIGNATURE initiative*
The Executive Board		
Chiara CERAMI	Delphi Facilitator	Principal Investigator
Alessandra DODICH	Delphi Facilitator	Principal Investigator
Andrea PANZAVOLTA	Project Manager	Coordinating Team
Giulia FUNGHI	Delphi Facilitator	Coordinating Team
Claudia MELI	Delphi Facilitator	Coordinating Team
Cristina FESTARI	External Reviewer	Methodologist
The Panel		
Maxime BERTOUX	France Representative, Psychologist, Social Cognition Expert	Advisor
Fiona KUMFOR	Psychologist, Social Cognition Expert	Advisor
Jan VAN DEN STOCK	Belgium Representative, Psychologist, Social Cognition Expert	Advisor
Christian CHICHERIO	Switzerland-French section Representative, Psychologist, Clinical Researcher	National Collaborator
Florencia CLARENCE	Argentina Representative, Psychologist, Clinical Researcher	National Collaborator
Fabricio Ferreira de OLIVEIRA	Brazil Representative, Neurologist, Clinical Researcher	National Collaborator
Marco FILARDI	Italy Representative, Psychologist, Clinical Researcher	National Collaborator
Sarah MACPHERSON	UK Representative, Psychologist, Social Cognition Expert	National Collaborator
Jordi A. MATIAS-GUIU	Spain Representative, Neurologist, Clinical Researcher	National Collaborator
Maxime MONTEMBEAULT	Québec Representative, Psychologist, Clinical Researcher	National Collaborator
Leonardo SACCO	Switzerland-Italian section Representative, Neurologist, Clinical Researcher	National Collaborator
Ann-Katrin SCHILD	Germany Representative, Psychologist, Clinical Researcher	National Collaborator
Marc SOLLBERGER	Switzerland-German section Representative,	National Collaborator

Name, SURNAME	*Role in the Delphi Procedure*	*Role in the SIGNATURE initiative*
	Neurologist, Clinical Researcher	
Miguel TABUAS-PEREIRA	Portugal Representative, Neurologist, Clinical Researcher	National Collaborator
Esther VAN DEN BERG	The Netherland Representative, Psychologist, Social Cognition Expert	National Collaborator
Stefano CAPPA	Neurologist, Social Cognition Expert	Member
Agustin IBANEZ	ReDLat Representative, Psychologist, Social Cognition Expert	Member
Giancarlo LOGROSCINO	FRONTIERS Consortium Representative, Neurologist, Clinical Researcher	Member
Camillo MARRA	Italian Association of Neurology for dementia Representative, Neurologist, Clinical Researcher	Member
Costanza PAPAGNO	FESN Representative, Neurologist, Social Cognition Expert	Member
Olivier PIGUET	Psychologist, Social Cognition Expert	Member
Simone POMATI	INS cross-cultural needs working group Representative, Neurologist, Clinical Researcher	Member
The Advisory Board		
Marina BOCCARDI	Scientific & Methodological Advisor	Methodologist
Laura INVERNIZZI	FTD Caregiver Association Representative, World FTD United and Italian FTD Association	Member
Mario POSSENTI	AD Caregiver Association Representative, Alzheimer Europe and Federazione Alzheimer Italia	Member
Magda TSOLAKI	AD Caregiver Association Representative, Greek Federation of Alzheimer's disease	Member
Marianna TSATALI	Expert of Neuropsychology Practice in people with disabilities	Member

2.2 Delphi methodology and procedure

In this project, we applied the Delphi methodology according to previously reported procedures [12, 13]. In detail, the EB reviewed the current literature and the results of the *SIGNATURE* clinical survey [8] and defined the panel for the Delphi procedure. Then, the facilitators drafted the first version of the Delphi questions, which was submitted to the external reviewer who assessed whether the items were sufficiently clear, neutral, informative, and complete. The Delphi questionnaire was then shared with all panelists via a web-based platform (i.e., Qualtrics) together with instructions to respond to each topic

based on their expert opinion, experience, and evidence from the state-of-the-art. The Delphi procedure was performed during the 2-day hybrid First *SIGNATURE* Workshop held at the Scuola Universitaria Superiore IUSS in Pavia, Italy. Details of the event can be found at the following link https://sites.google.com/unitn.it/signature-initiative/events/. See Fig. 1 for details on the Delphi approach including the preliminary activities and the Delphi procedure.

Questionnaire definition. The EB identified four target topics for the Delphi consensus assumptions aimed at defining: Clinical context of use and practice in socio-cognitive testing for the diagnosis of NCDs in memory clinics by specialists in dementia *(Section 1)*; Relevance of socio-cognitive assessment in cognitive decline and the dementia diagnostic framework *(Section 2)*; Facilitators and obstacles for the implementation of socio-cognitive testing in clinics *(Section 3)*; Priorities for future research on socio-cognitive testing in NCDs *(Section 4)*. See Supplementary Table 1 for details of the questions per section.

Agreement, multiple choice, relevance and open text questions were used to assess consensus assumptions. See Supplementary Table 1 for the full list of questions. Panelists were allowed to abstain from voting when the topic of the question was outside their area of expertise. All responses were substantiated with justifications.

Convergence threshold. For agreement and the multiple-choice questions, we established a predefined threshold of 70% of non-abstaining panelists for agreement in Round 1. Those questions for which no consensus was reached were then reformulated based on panelists' comments and presented in Round 2. In this case, an absolute majority (50%+1) was sufficient for agreement. Responses to relevance questions were summed up into a single score and categorized according to the following range: ≥99 - *Very Important* (corresponding to a score of 'very important' assigned by at least half of the panelists, and the other half assigning a score of 'important'); 77 ≤ x < 99 - *Important* (corresponding to a score of 'important' assigned by at least half of the panelists, and the other half assigning a score of 'neutral'); 55 ≤ x < 77 - *Neutral* (corresponding to a score of 'neutral' assigned by at least half of the panelists, and the other half assigning a score of 'not important'); 33 ≤ x < 55 - *Not Important* (corresponding to a score of 'not important' assigned by at least half of the panelists, and the other half assigning a score of 'not important at all'); < 33 - *Not Important At All* (when the majority of the panelists assigned a score of 'not important at all'). Open text questions were only used in Round 1 to derive a list of facilitators and obstacles that were voted on in terms of relevance in Round 2.

2.3 Evidence supporting the Delphi procedure

To help the Delphi panelists to make informed decisions, we provided them with the following background information: a) top-down evidence from a literature review on available socio-cognitive measures for the early and differential diagnosis of mild and major NCDs; b) bottom-up evidence derived from results of our previous clinical survey [8].

Top-down evidence. For a), starting from a previous systematic review [14] that investigated clinically validated socio-cognitive measures for the diagnosis of behavioral variant of frontotemporal degeneration (bvFTD), we updated and expanded the literature review up to July 2023 according to the guidelines of the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) statement [15]. We considered only original studies published in English, excluding reviews, case reports, and guidelines. Search strings were harmonized across NCD syndromes (mild or major) and etiological diagnosis (e.g., AD, FTD, etc.). See Supplementary Table 2 for details on search strings. Relevant references from personal knowledge and citation-tracking articles were also included. Titles and abstracts were screened, and potentially relevant studies were then examined according to the following criteria: 1) use of either a clinical or biomarker-based diagnosis for patient classification, 2) quantitative scoring of a socio-cognitive measure or social cognition battery; 3) availability of diagnostic accuracy data for socio-cognitive tests, including metrics such as sensitivity, specificity, accuracy, positive/negative predictive value, or positive/negative likelihood ratios. The quality of evidence was rated by A.D., C.C., A.P. and C.M. using the Quality Assessment of Diagnostic Accuracy Studies (QUADAS-2, [16]), a tool designed to provide a formal assessment of the quality of primary studies included in a review to avoid bias. Raters were trained in QUADAS-2 and had fine-tuning methodological meetings to ensure uniformity and reproducibility of data extraction. Data were recorded in an Excel spreadsheet, modified from Dodich et al., 2021[14].

Bottom-up evidence. The SIGNATURE clinical survey results [8] were presented during the workshop and provided on a dedicated Google Drive folder to all the panelists prior to the Delphi Round 1 to inform them on the clinical evidence regarding the state-of-the-art of socio-cognitive assessment in memory clinics, the best-known and used tools for assessing social-cognitive function across ten European and non-European geographical areas, the perceived relevance of assessing social cognition in NCDs, and the hurdles envisioned for the use of socio-cognitive measures in real-life clinical scenarios.

3. RESULTS

3.1 Top-down evidence

An updated literature review of studies on socio-cognitive measures available in clinics identified a total of 971 papers that were screened for subsequent processing (see Supplementary Fig. 1). After excluding duplicate records, wrong publication type and off-topic and not-English papers, only 65 papers were assessed for eligibility. Forty-four papers were excluded because: 1) only the combined diagnostic accuracy of social and other cognitive measures was reported, without specific information on the accuracy of social tasks; 2) accuracy values were calculated using multifactorial models from which the exclusive weight of the social cognition measures was not obtainable; or 3) mixed samples of mild/major NCDs were included. The remaining 21 papers provided validated measures of the accuracy of single or combined socio-cognitive measures in major NCDs, two of them also including mild NCDs (see Supplementary Table 3). Of these, ten studies explored the accuracy of tests of emotion recognition using facial stimuli (e.g., Ekman 60 faces and its variants) [17–26], one test of emotional recognition

using non-visual stimuli [27], eight using theory of mind tasks (Story-based Empathy Task, Reading the Mind in the Eyes test, the Faux-pas test, and experimental mentalizing music task) [19–22, 25, 28–30], eight using the Social Cognition and Emotional Assessment (SEA) battery or its short version (mini-SEA) [21, 22, 25, 31–35], and six using other social cognition facets (e.g., empathy and socio-emotional sensitivity) [20, 26, 28, 31, 36, 37]. These papers reported good to excellent accuracy values for emotion recognition and theory of mind tasks in the early and differential diagnosis of bvFTD and good clinical performance in differentiating amnestic mild cognitive impairment (MCI) and AD versus healthy control subjects (HC). Only one study explored the clinical diagnostic performance of emotion recognition and theory of mind in the differential diagnosis of frontotemporal lobar degeneration syndromes [19]. The quality of evidence assessed with QUADAS-2 was judged as strong in two studies [19, 31] showing an overall judgment of low risk of bias or low concern regarding applicability. Ten studies showed low/moderate risk of bias [17, 21, 22, 27, 29, 32–34, 36, 37]. The main methodological limitations were related to bias in: 1) patient selection (i.e., lack of consecutive, unspecified selection of subjects or inappropriate exclusions, n = 6); 2) reference standards (i.e., either possible inaccurate to classify the target condition or low availability of in vivo biomarkers, n = 4); and 3) flow and timing (i.e., unclear or inappropriate intervals between the index test(s) and the reference standard, and diagnoses not assessed against the same reference standard, n = 5). See Supplementary Table 4 for a summary of the QUADAS-2 assessment for all included studies.

3.2 Bottom-up evidence

Results from the *SIGNATURE* survey data collection including 413 responses from 10 European and Latin America geographical regions reported the Ekman-60 faces (EK-60F; a well-known test for recognizing facial affect) test or its variants as the most well-known and used task overall, followed by two tests of theory of mind (i.e., the Faux-Pas and the Reading the Mind in the Eyes – RMET tests, or their variants) [8]. The EK-60F and the Faux-Pas tests were reported as known/used in 10/10 geographical regions, while the RMET in 8/10 [8]. In addition, the mini Social cognition & Emotional Assessment (Mini-SEA; a test combining facial emotion recognition and a selection of faux-pas) was known/used in 5/10 geographical regions and the Story-based Empathy task (SET; a test evaluating attribution of emotion and intention to others) in 6/10 [8].

3.3 Results of Section 1 – Clinical context of use and practice

Two Delphi runs were performed. Regarding recommendations for clinical use, the panelists agreed that social cognition testing should be routinely included in the assessment of every patient as part of the diagnostic definition for NCDs (Round 1, Q1; votes: 86.4% of agreement). However, social cognition assessment in follow-up evaluations was recommended only for selected cases based on the presence of socio-cognitive deficits at the first assessment or based on symptoms reported at the follow-up visit (Round 2, Q2r; votes: 95.5% of agreement). First-level evaluation was voted as the most appropriate context for the assessment of social cognition in major (Q3) and mild (Q4) NCDs (Round 1, Q3: votes 81.8% of agreement; Q4: 90.9%). Socio-cognitive assessment should include at least two tests

evaluating different facets of social cognition (Round 1, Q5; votes: 95.4% of agreement) as well as a measure of social cognitive domain functioning (e.g., emotion recognition) and a measure to quantify changes in social behavior (e.g., sensitivity to social signals in real life) (Round 1, Q6; votes: 81.1% of agreement). See Fig. 2 for a summary of Section 1 recommendations and details on the agreement rates.

The figure list recommendations for the clinical context of use and practice in socio-cognitive testing for the diagnosis of NCDs and on the relevance of socio-cognitive assessment in the different NCD diagnostic frameworks. See Supplementary Materials for details on the questions and agreement scores. *RMET: Reading the Mind in the Eye Test; SET: Story-based Empathy task; Mini-SEA: mini-Social cognition & Emotional Assessment; IRI-EC: Interpersonal Reactivity Index – Empathic Concern; IRI-PT: Interpersonal Reactivity Index - Perspective Taking.*

3.4 Results of Section 2 – Relevance in NCD diagnosis

Panelists rated the assessment of emotion recognition in major NCDs (Round 1, Q7), and emotion recognition and cognitive ToM in mild NCDs (Round 1, Q8) as “very important”. The panel agreed on the use of the EK-60F test or its variants (Round 1, Q9; votes: 90% of agreement), the Faux-pas test (Round 2, Q10; votes 65% of agreement) and the Empathic Concern and Perspective Taking subscales of the Interpersonal Reactivity Index (IRI) questionnaire (Round 2, Q12r; votes: 57.9% of agreement) to assess emotion recognition, mentalizing, and empathy facets of social cognition respectively in major and mild NCDs. Panelists also agreed on using the RMET, the SET, and the mini-SEA as other tools to assess social cognition deficits in major and mild NCDs (Round 1, Q11; votes: 70% of agreement). No consensus was reached on using the revised version of the Self-monitoring Scale (r-SMS) to assess self-monitoring and awareness in NCDs. Specifically, the panelists recognized the evidence in favor of the use of r-SMS in frontotemporal dementia. However, based on the lack of information about the overall validity in mild and major NCDs, a consensus could not be found. Poor knowledge about the test and limited clinical data were raised as relevant points, which represent research priorities for its use in clinical practice. See Fig. 2 for a summary of the Section 2 recommendations and Supplementary Fig. 2 for details on agreement rates.

3.5 Results of Section 3 – Facilitators and obstacles

Clinical and methodological obstacles (e.g., lack of validated standardized tools, lack of normative data) emerged as the most relevant factors influencing socio-cognitive measure use in clinical practice, together with implementation hurdles (e.g., lack of professional expertise and training for professionals, lack of time for the neuropsychological assessment) and external barriers (e.g., resistance to change in clinical practice, insufficient communication among research and clinical communities). Facilitators included the availability of tests without cognitive load in other domains, the availability of quick to administer cognitive tasks and the availability of cross-cultural and cross-language information. Automatization in data scoring and acquisition and lack of digital tools were rated only as marginal obstacles. See Fig. 3 for the full list of facilitators and obstacles.

3.6 Results of Section 4 – Priorities for future research

Considering priorities for future research, the panel agreed that social cognition assessment should include a subset of cognitive screening tests administrable remotely using digital tools but only if an in-person assessment is not possible (Round 2, Q15r; votes: 54.6% of agreement). The panel rated either patient- or informant-administered measures with supervision (Round 1, Q16) as “Important”. Tasks or interview administration without supervision were rated overall as less relevant. Tablet-based neuropsychology platforms and teleneuropsychology via videoconferencing were considered relevant scenarios in the diagnostic framework (Round 2, Q17) and in the follow-up neuropsychological evaluation (Round 2, Q18). Other digital tools, such as wearables, virtual/augmented reality and eye-tracking, were rated as less important.

The figure shows in bold the facilitators and obstacles rated as “Very Important”, and in nonbold those rated as “Important”.

4. DISCUSSION

In this paper, we provide actionable recommendations to bridge the gap between research and clinical practice, advancing the implementation of socio-cognitive assessment within NCDs diagnostic procedures. As evidenced by the results of the *SIGNATURE* survey [8], the selection of social cognition measures is often influenced by individual clinical preferences, availability of measures, the level of expertise and local resources. This leads to significant differences in patient assessment and provision of care [38]. These recommendations aim to provide a general framework and guide the definition and implementation of social cognition assessment in NCDs.

Socio-cognitive testing is recommended for all patients suspected of mild or major NCDs during the baseline assessment to facilitate more accurate diagnosis. Moreover, it should be included in the follow-up neuropsychological evaluation of selected patients for better monitoring of the disease progression, based on the presence of socio-cognitive deficits at their initial assessment or on symptomatology reported at the follow-up clinical visit. Indeed, the DSM-5 recommendations support the assessment of social cognition; however, no specific details are provided for major/mild NCDs or differential frameworks (i.e., diagnostic or follow-up). The results of this study help to operationalize the DSM-5 recommendations based on current evidence and expertise in the field to improve the detection rate in clinical practice of those patients not presenting with an AD phenotype. As suggested by the APA recommendations [39], which recommend that two tests provide a more comprehensive approach to accurately capture the multifaceted nature of cognitive domains, the panel agreed that socio-cognitive testing should include at least two tests that assess different facets of the social cognition domain, and that these should be complemented by a measure that quantifies changes in social behavior. Indeed, the use of a single test to evaluate the complexity of social cognition changes in NCDs poses significant risks for inaccuracy or misinterpretation and may fail to capture the breadth of impairments across the various subdomains of social cognition. It should be noted, however, that the use of more than one test

per cognitive domain may be limited in some clinical settings for reasons of feasibility concerns (e.g., lack of resources or time constraint).

Different tests available in clinics were considered by the panel in terms of their current utility for the detection of social deficits. However, as pointed out by the panelists, some tools pose significant challenges, such as inadequate psychometric properties [40], or lack normative data or the absence of cross-cultural validated tools that hamper their harmonized use in memory clinics (for a list of tests available in different countries see SIGNATURE website in measures subsection). Future efforts should promote the development of more reliable tools, able to overcome these current limitations, possibly providing translations and cultural adaptations for different countries. This is a crucial point, as one could expect that social-cognitive measures - more than other cognitive domains - are heavily influenced by local specificities, social norms, and language nuances [41]. Variability in cultural contexts, characterized by different social norms, complex mental state definitions (e.g., schadenfreude) and non-verbal behaviors may lead to misinterpretations of individuals' performance if a test is used in a context other than that for which it was designed [42].

In this regard, it is important to note that most neuropsychological tasks have been developed and validated in Western, educated, industrialized, higher socio-economic status, and largely democratic countries. Applying these norms to individuals from societies or countries with very different social contexts can lead to misinterpretation and misdiagnosis of cognitive impairments. The introduction of computerized adaptive testing through digital tools might advance the field of socio-cognitive testing by designing more flexible culture-broad tools able to capture deficits in social cognition [43]. In addition, more inclusive practices in clinical neuropsychology would improve appropriateness of cognitive testing in sexual and gender minorities [44], since they could express vulnerabilities in socio-cognitive functioning, which remain currently unexplored [45, 46], as a consequence of specific environmental factors (e.g. stigma). Adapting socio-cognitive tools to reach a broader audience in clinics should also include populations with disabilities who have limited access to this type of evaluation [46]. Collaborative international participatory research, as also reported by the facilitators, is essential for addressing the challenges of social cognition assessment from a broad perspective, while also considering specific needs, such as those related to disabilities, and cultural differences.

Another key facilitator of socio-cognitive assessment is the definition of a clear conceptual and theoretical framework of social cognition. Increasing knowledge of how subdomains of social cognition develop, function, and interact is a critical step in understanding the foundations of social behavior and how it can be measured in the clinical context of NCDs. Studies aimed at disentangling the interdependence of social cognition subdomains are needed to develop theoretical models from which neuropsychological batteries may be derived, as is already available for other cognitive domains (e.g., the Birmingham Object Recognition Battery for visuo-spatial assessment [47]). Recent efforts to promote the use of consensual terminology [48], and other initiatives could help (https://shorturl.at/nzWQw). In addition to the above-mentioned clinical, methodological (e.g., cross-culturally validated tests with good psychometric properties) and implementation (e.g., brief socio-

cognitive tasks feasible in clinical settings) priorities, other relevant factors in the use of socio-cognitive testing in clinical scenarios have been identified by the panelists. These include the presence of external factors such as the resistance to changing clinical practice and the availability of copyright-free tools. These issues deserve special attention and can be addressed in the context of multicenter projects. Besides, the cross-cultural translation of these results in other socio-cultural settings is still untested. International networks, such as those promoted by the Cognition Professional Interest Area (PIA) of the International Society to Advance Alzheimer's Research and Treatment (ISTAART PIA-Cognition), can help to raise awareness among multiple stakeholders.

Declarations

Ethics Approval

The study protocol was approved by the IUSS University Ethics Committee (IUSS-University of Pavia; Protocol 164/24).

Consent for publication

Not applicable

Availability of data and materials

Datasets generated and analyzed in this study are available from the corresponding author on request.

Competing interests

Chiara Cerami has been granted for consultancy by Newel Health srl, LinkForMed srl, Ethos srl. Stefano Cappa has received speaker honoraria from Biogen, Roche and Nutricia and is member of the Scientific Advisory Board of Brain Control. Alessandra Dodich has received funding through her institution from Associazione Alzheimer Trento ODV. Cristina Festari has received funding through her institution from the Alzheimer’s Association and Italian Ministry of Health. Giancarlo Logroscino has served as investigator for clinical trials sponsored by Biogen Pharmaceuticals, Axovant, Alector, Denali, Roche, Eisai, Genentech, Amylyx, Piam Farmaceutici SpA and has been granted for speech and consultancy by EISAI, Roche, Lilly, Piam Farmaceutici Spa, Biogen. Jordi Matias-Guiu has been granted for speech and consultancy by Almirall, Alter, Fujirebio, Esteve, KRKA and Schwabbe, Araclon, Eisai, and Schwabbe and is supported by grants from Instituto de Salud Carlos III and Fundacion Conocimiento Madri+D. Fabricio Ferreira de Oliveira has been granted for consultancy by Gerson Lehrman Group, Atheneum Partners, Guidepoint, Lionbridge. He is supported by FAPESP – The State of São Paulo Research Foundation (Grant #2015/10109-5) and is a board member of AAN Global Strategies Subcommittee, Awards Committee of the International Parkinson and Movement Society, ISTAART PIA Biofluid Based Biomarkers working group, ISTAART PIA Neuropsychiatric Syndromes and ESF Committee of Experts. Leonardo Sacco has served as investigator for clinical trials sponsored by Biogen and was member of the Advisory Board of Roche and Eisai. Marc Sollberger has been granted for speech and consultancy by

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Authors' contributions

All authors (C.C., A.D., G.F., C.M., A.P, C.F., T.C., C.C., F.C., F.F.O., M.F., A.I., L.I., T.L., G.L., S.E.M., R.M., C.M., J.A.M.G., M.M., C.P., S.P., M.P., O.P., L.S., A.K.S., M.S., M.T.P., M.T., E.V.B., S.F.C., M.B., F.K., J.V.S., M.B., and K.A.W.B) contributed to the study conception and design. Material preparation was performed by the Executive Board (C.C., A.D., G.F., C.M., A.P.). Data collection and analysis were performed by A.P, G.F., and C.M.. The first draft of the manuscript was written by A.D. and C.C. All authors (C.C., A.D., G.F., C.M., A.P, C.F., T.C., C.C., F.C., F.F.O., M.F., A.I., L.I., T.L., G.L., S.E.M., R.M., C.M., J.A.M.G., M.M., C.P., S.P., M.P., O.P., L.S., A.K.S., M.S., M.T.P., M.T., E.V.B., S.F.C., M.B., F.K., J.V.S., M.B., and K.A.W.B) reviewed the manuscript for content, read and approved the final version.

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Figures

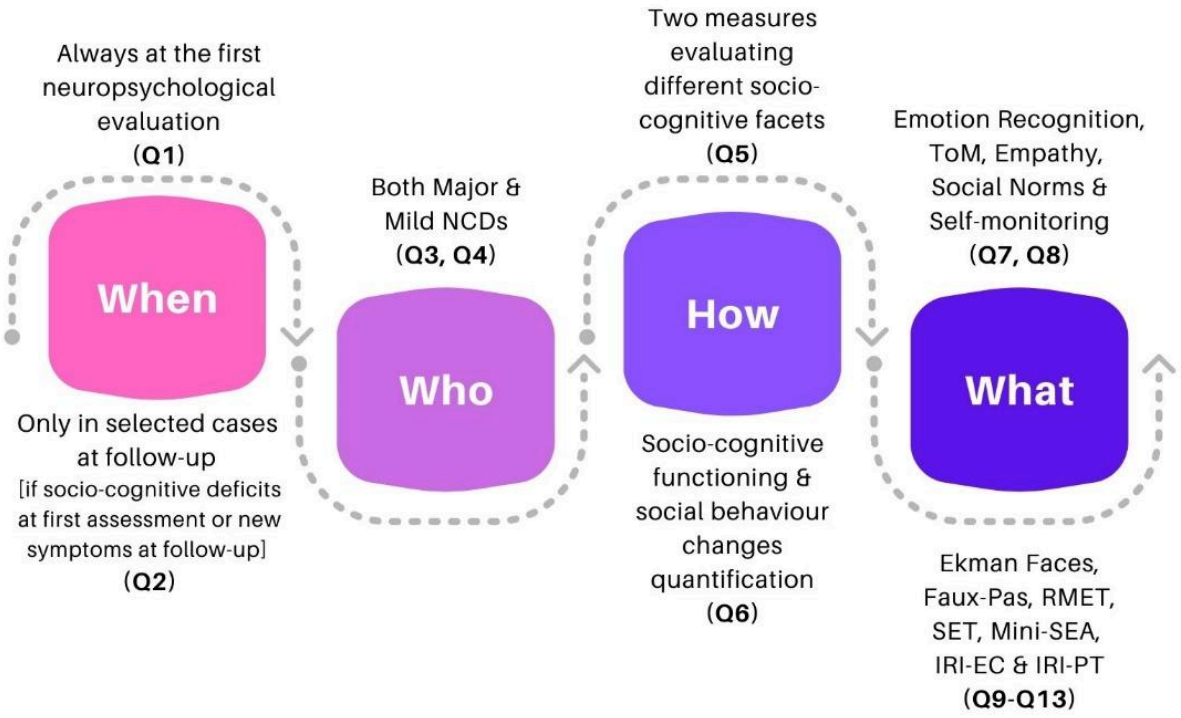

Figure 1

Clinical Applications and Relevance of Socio-Cognitive Assessment in NCDs.

The figure list recommendations for the clinical context of use and practice in socio-cognitive testing for the diagnosis of NCDs and on the relevance of socio-cognitive assessment in the different NCD diagnostic frameworks. See Supplementary Materials for details on the questions and agreement scores. *RMET: Reading the Mind in the Eye Test; SET: Story-based Empathy task; Mini-SEA: mini-Social cognition & Emotional Assessment; IRI-EC: Interpersonal Reactivity Index – Empathic Concern; IRI-PT: Interpersonal Reactivity Index - Perspective Taking.*

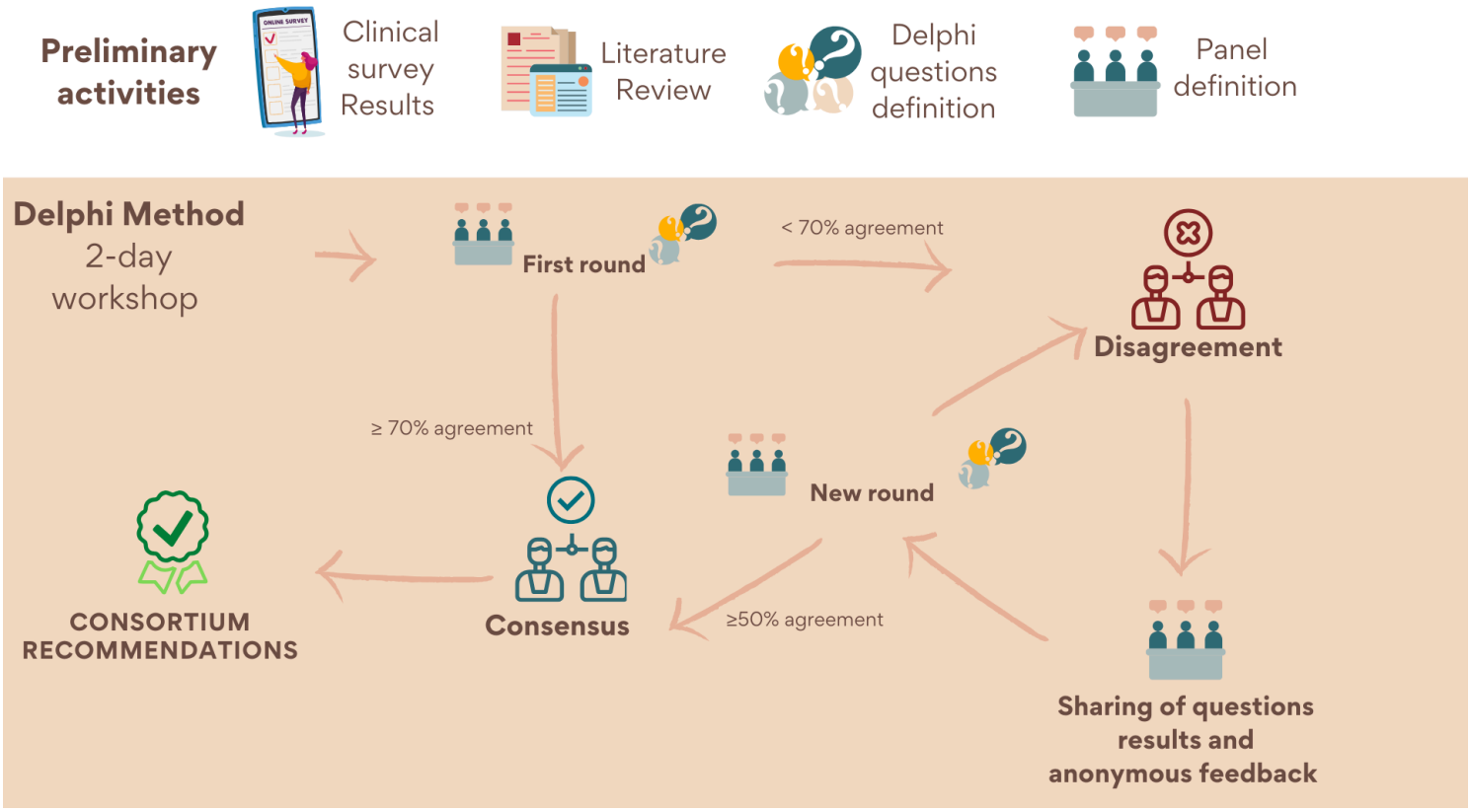

Figure 2

Summary of the Delphi approach including preliminary activities (upper panel) and Delphi procedure (lower panel).

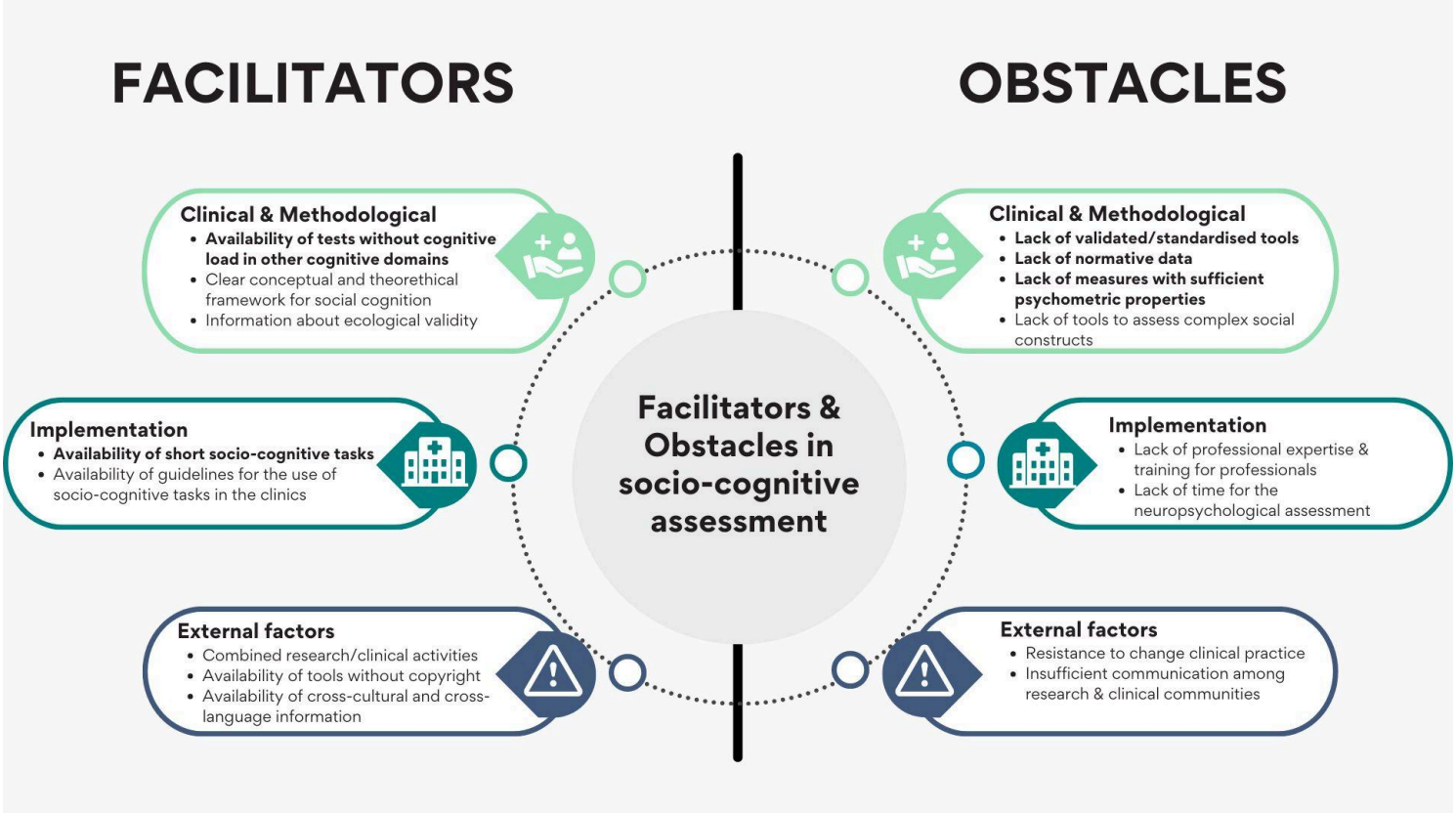

Figure 3

List of facilitators and obstacles identified with Section 3 questions.

Supplementary Files

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- SignatureDelphiSupplementarymaterialAlzhResTerFinal.docx