



## Review Article

# A multidisciplinary approach to insanity assessment as a way to reduce cognitive biases



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## ABSTRACT

Insanity assessment requires the evaluation of the psychopathological condition that underlies the *mens rea*. Psychopathological evaluation may be quite challenging due to (i) absence of biomarkers; (ii) low inter-rater reliability; (iii) presence of cognitive bias. This intrinsic low reliability of forensic psychiatric diagnosis does impact on insanity assessment, leading to arbitrary and unjust legal outcomes for the examinee. Thus, strategies to improve the reliability of insanity evaluation are strongly needed. A multidisciplinary approach has been proposed as a way to enrich clinical diagnosis with reliable and biologically founded data, thus minimizing subjectivity, reducing controversies and increasing inter-subject concordance in insanity assessment. By discussing a real case, here we show how the convergence of multiple indices can produce evidence that cannot be denied without introducing logical fallacies. Applying this approach, the forensic discussion will move from the presence/absence of psychopathology to the impact of psychopathology on insanity. This article illustrates how a multidisciplinary evaluation, which integrates neuroscientific methods with the classical insanity assessment, may lead to a more accurate approach in insanity evaluation. Critically, this approach will minimize the impact of cognitive bias on insanity opinion and thus result in an improvement of the whole criminal justice process.

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## 1. Introduction

In forensic sciences, the same evidence can be interpreted differently by different experts [1]. This is particularly evident in insanity assessment, which is often requested in criminal trials to evaluate if the defendant *mens rea* is abolished or weakened as a result of brain insult or psychiatric conditions. Furthermore, insanity assessment also aims to evaluate the causal link between the psychopathological condition that led to the diminished *mens rea* and the *actus reus*. To date, insanity evaluation is performed almost exclusively by the means of clinical interviews. This may become highly complicated when dealing with psychiatric disorders. Indeed, psychiatric diagnosis is extremely challenging for many reasons.

First, the absence of biomarkers, defined as a characteristic that can be objectively measured and evaluated as an indicator of normal or pathogenic processes [2] greatly contributes to increase variability of psychiatric diagnoses [3,4]. These biological features are included within the diagnostic criteria for neurological disorders, as core or supporting features. For instance, despite the core diagnostic criteria for Alzheimer's disease are clinical (i.e., memory loss), the volume of the hippocampus and the abnormal level of tau and amyloid proteins are biomarkers included within the diagnostic criteria as supporting features [5]. Thus, the presence of biomarkers enables to corroborate the clinical diagnosis. This is not true for the diagnoses of psychiatric disorders, in which biomarkers have not yet been identified.

Second, the diagnostic process in psychiatry suffers from a low inter-rater reliability [6–10], defined as the degree of agreement between different psychiatrists on the same diagnosis. This likely is the consequence of the absence of biomarkers, the presence of cross cutting symptoms and the high comorbidity rates, that further complicate the diagnosis. Critically, some researches also demonstrated that clinical assessments conducted using structured interviews are more reliable than clinical assessments conducted using unstructured interviews [6–9].

Third, forensic sciences, including psychiatric diagnoses, are highly prone to cognitive biases. A huge body of literature is now emerging on this fascinating topic [11–20], as biases have been identified at every stage of clinical evaluation, both at the level of observation and at the level of conclusions [12,14]. In other words, different clinicians may detect different symptoms or may provide a different interpretation for the same symptoms. A clear example of this last issue is the notorious case of Breivick, in which, based on the same clinical observations, the prosecutor's expert diagnosed him with paranoid schizophrenia, while the defense's expert with severe narcissistic personality disorders, thus reaching remarkably different conclusions [21]. One example of cognitive bias is the allegiance effect, which consists in interpreting the symptoms in accordance with the adversarial side that retains the expert [22,23].

This intrinsic unreliability in psychiatry clearly impacts on insanity assessment. Indeed, studies indicate that reliability among forensic evaluators addressing legal sanity may be poorer than the field has tended to assume [24]. A recent systematic review and meta-analysis of previous studies investigating inter-rater reliability of sanity opinion [25] revealed that studies presented a wide range of reliability estimates, with percentage of agreement ranging from 57 % to 100 % and inter-rater agreement index ranging from 0.28 to 1.0. The meta-analysis performed returned estimates of 0.41 (95 % CI: 0.29–0.53) for sanity opinions.

The lack of consensual criteria for sanity opinions and causal link assessments makes it extremely difficult to reach an agreement on insanity evaluations. Indeed, according with the Daubert ruling and its Italian equivalent (Cozzini ruling, Supreme Court of Cassation number ruling 43786/2010), which identify four

criteria that scientific pieces of evidence must meet to be considered as a valid proof in criminal trials, the error rate should be known and acceptable. Thus, it is clear that, in a field like insanity, where judges need to hold someone's responsible for their actions beyond any reasonable doubt, the error rate of psychiatric interview by itself (53 % [8]) or as the result of insanity evaluations (57 % in the worst case scenario [25]) cannot be considered acceptable at all.

Within this framework and in the absence of likelihood ratio methods available for other forensic discipline [26], the neuroscientific approach can provide a unique contribution supporting the clinical diagnosis with objective, reliable and biologically founded data according with the principle of convergence of evidence. In the current paper, through the description of a real forensic Italian case, we aim to underline the importance of using a multidisciplinary approach in the insanity assessment. We propose that this multidisciplinary approach should include a clinical psychiatric evaluation using a semi-structured interview alongside the unstructured interview, a psychopathological evaluation, a neuropsychological evaluation [27] and, when indicated, a brain magnetic resonance imaging (MRI) scan examination, whose use and interpretation should strictly follow recent guidelines [28].

## 2. Case report

### 2.1. The facts

The defendant was a 55 male nurse in a private gastroenterology clinic. He was charged with sexual abuses, as he sexually abused unconscious patients, who had been anesthetized in preparation for gastroenterological procedures, regardless of their gender or age. An insanity evaluation was requested. The defendant provided a written informed consent to publish data and information pertaining his case.

### 2.2. The procedure of the psychiatric evaluation

The experts summoned by the judge (*Periti*) conducted the insanity assessment. The methodology they adopted was the unstructured interview. The only relevant medical information in the defendant anamnesis was the presence of a very big angioma in his left hemi-face. During the interview, the defendant appeared emotionally detached from the events. Clinical examination unveiled an inflated sense of his person and a exaggerated need for consideration. For instance, he vaunted excellent sportive results and claimed that thanks to his terrific sport results, despite his angioma, he had been very successful with women since adolescence. He added that his success in dating had increased his self-confidence and self-esteem. The clinical interview was constellated by sentences like the followings: “*All the patients fall in love with me*”; “*Patients keep my picture on their bedside table and kiss me every night*”; “*Patients stop me as I walk in the street, they bow and they kiss my hand*”. Though he was married, he admitted having had many extramarital relationships, which he represented as a sort of mission, as “*I have to please every woman as every one of them wants to have sex with me*”. In line with the above, during the examination encounters, the defendant used to hold his hand out to have it kissed by the consultants.

In order to evaluate the defendant's sexual attitudes, the *Periti* selected the Hendrick Sexual attitude scale [29], a self-report questionnaire evaluating permissiveness (i.e., permissiveness toward an open relationship); birth control (i.e., the responsibility in birth control); communion (i.e., the attitude toward the importance of melting together with sex partner); instrumentality (i.e., the attitude towards enjoying physical sex). The defendant

responses to the scale denoted a normal attitude toward sexuality (Table 1).

### 2.3. Disagreements on the clinical diagnosis

According to the *Periti*, the defendant merely manifested narcissistic traits and “a disharmonic personality”, but was not affected by any psychiatric disorder. Specifically, the features from different personality disorders that had emerged from the interview were not sufficient to sustain the diagnosis of a personality disorder.

On the contrary, the experts appointed by the defendant claimed that he had a severe Other Specified Personality Disorder (DSM-5 301.89), with mixed personality features including narcissistic, paranoid and borderline characteristics. This discrepancy in the clinical conclusions is of utmost relevance: indeed, according to Italian penal laws, while personality traits do not have any relevance on mental insanity, a severe personality disorder does have the potential to impact on insanity. This is regulated by the ruling of the Supreme Court of Cassation 9163/2005 (also known as the *Raso Ruling*), which states that personality disorders, though severe, may impact on insanity.

The *Periti* and the defense consultants reached different clinical diagnoses as they provided different interpretations in front of the same clinical symptoms. For instance, the *Periti* did not consider statements like the following “*Patients stop me as I walk in the street, they bow and they kiss my hand*” relevant to inform their diagnosis, while the same statements were considered indicative of an excessive ego (criterion A for the diagnosis of narcissistic personality disorder) by the defense consultants. In addition, the information on the extramarital relationship was considered indicative of social and personal adaptation by the *Periti*, while the defense experts considered the defendant’s extramarital relationship (and the motivations he offered) as indicative of low personal adaptation, emotional instability and grandiosity (criterion A for the diagnosis of narcissistic personality disorder). The above are just punctual examples that clearly demonstrate that clinical assessment alone is highly subjected to discordant interpretations by different experts. Thus, a cognitive bias is present at the level of the between-expert conclusions [14].

### 2.4. Causal link between the diagnosis and the criminal act

According to the defense, a causal link between the psychopathological picture (that is, a severe narcissistic personality disorder) and the *actus reus* existed as well. In this case, an identifiable triggering factor was present: one evening, while the defendant was trying to approach a woman in a pub, she had an unexpected reaction and yelled at him, calling him ‘a monster’ (explicitly referring to the angioma on his face). It is worth to note that this unpleasant event would have been dismissed as trivial by most persons in his place, as he had met that woman the very same

evening and she was only one of the many women within his compulsive seductive acting. On the contrary, the woman behavior appeared profoundly unacceptable to the defendant, due to his underlying severe narcissistic personality disorder. Her abrupt and unexpected response resulted in a narcissistic wound. As a matter of fact, he started sexual abuses shortly after this traumatic episode. It is relevant to note that the criminal acts consisted in sexually abusing people that could not refuse him, as they were anesthetized. Furthermore, during the clinical interview, he repeatedly stated that he had been seeking revenge for what “*people had done to him*”, revealing clear pathological features. The indiscriminate nature of his sexual abusing behaviors (as he showed no preference for age or gender of his victims) is another aspect of his pathological condition.

### 2.5. The importance of multidisciplinary evaluation

Considered that the outcome of the insanity assessment after the clinical interview led to openly discordant conclusions between the *Periti* and the defense consultants, the defense asked for a multidisciplinary assessment to be performed to complement the unstructured psychiatric interview [27]. Thus, psychopathological and neuropsychological assessments were performed, along with a structural brain MRI scan exam.

The psychopathological assessment was conducted capitalizing on proper psychopathological instruments consisting in self-report questionnaires that include internal indices of malingering and that are automatically corrected by an online software, thus reducing the proneness to biases during data analysis. To measure overall psychopathology, the Minnesota Multiphasic Personality Inventory-II (MMPI-2; [30–32]) was administered. The MMPI-2 revealed an above threshold score at the Psychopathic Deviate (Pd: T=72); Paranoia (Pa: T=69); Anxiety (Anx: T=68) scales. The analysis of personality disorders revealed the possible presence of borderline (T=69) and paranoid (T=65) personality disorders. The Harris and Lingoes subscales analyses [33] revealed an above threshold score at the following sub-scales: Brooding (D5: T=73); physical malfunctioning (D3: T=85), social alienation (Pd4: T=82), self alienation (Pd5: T=75), persecutory ideas (Pa1: T=72). To investigate in more depth the possible presence of personality disorders, the Millon Clinical Multiaxial Inventory-II (MCMI-II, [34,35]) was administered as well. The MCMI-II results were particular relevant to solve the controversies between personality trait and personality disorder, as they revealed that the indices for the presence of borderline (BR=90), paranoid (BR=85) and depressive (BR=87) personality disorders were all well above the threshold for personality disorder (BR=85). The MCMI-II also identified above-threshold presence of anxiety (BR=87) and dysthymia (BR=95).

The neuropsychological evaluation was conducted by means of the social cognition battery [36], that has been specifically designed to investigate social and cognitive abilities that are relevant for self-determination (see Table 2). This battery includes the assessment of: i) the ability to infer what others are thinking (theory of mind); ii) the ability to infer the emotions of others (emotional attribution); iii) ability to discriminate normal from abnormal behaviors; iv) the ability to discriminate legal from moral violations and to estimate the severity of violations. The results revealed that the defendant theory of mind was severely impaired; that the defendant manifested severe difficulties in the identification of fear, happiness and anger in others and tended to greatly underestimate the severity of behavioral violations (both legal and moral). These results are of critical relevance for many reasons. First, they denote an at least partial impairment in the ability of self-determination. Second, these impairments reflect criteria for specific personality disorders. For instance, the deficit

**Table 1**

Defendant’s results at the Hendrick Sexual attitude scale as reported in the *Periti* expert opinion. Numbers indicate the defendant’s score and the mean control group score, respectively. The control group data were reported in the expert report and are available in the original reference [29], in which the standard deviations were not reported.

Hendrick Sexual attitude scale- subscale	Defendant’s score	Mean score in the control group	Interpretation
Permissiveness	2.38	3.3	Normal
Birth control	1.14	1.8	Normal
Communion	2.22	2.1	Normal
Instrumentality	3.66	3.3	Normal

**Table 2**

Defendant's results in the neuropsychological evaluation. Theory of Mind test: the defendant was asked to read short stories and to decide whether what the character said was true or not. For instance: "Katia and Emma are playing. Emma takes a banana and says: <<Katia look, this is a telephone!>>. Is what Emma is saying true?". Emotional Attribution test: the defendant was asked to identify the emotion the character was feeling in different short stories. For instance: "Kevin's ice cream falls on the ground. What does Kevin feel?". Social situation test: the defendant was asked to judge the character's behavior as normal or abnormal and to estimate the abnormality severity. For instance: "Sharon went to the park for a picnic. It was very sunny and hot. Sharon decided to have her picnic naked. Is this behavior normal or not? How severe is the violation?". Moral vs Legal Violations: the defendant is presented with short legal ("A boy hit another boy") or moral ("a boy interrupts the teacher to talk to his friend") behavioral violations and he has to decide whether or not this behavior is normal, how severe it is, and whether or not this behavior would be normal in a country where there are no laws that forbid it, or in a school where the teachers would allow it.

	Defendant Score	Cut-off	Z score	Interpretation
<b>Theory of Mind</b>	8/13	≥12	-39.3	Severely Impaired
<b>Emotion Recognition</b>				
Sadness	8/10	≥6	0	Normal Range
Fear	7/10	≥8	-2.0	Impaired
Embarrassment	9/12	≥8	0.5	Normal Range
Disgust	3/3	>2	0.4	Normal Range
Happiness	7/10	≥10	-5.6	Severely Impaired
Anger	3/10	≥6	-4.2	Severely Impaired
Envy	3/3	≥1	0.9	Normal Range
<b>Social Situation Test</b>				
Normal Behavior	13/15	≥13	-1.6	Borderline
Abnormal behavior	23/25	≥22	-1.0	Normal Range
Violations Severity	48/75	≥45	-0.8	Normal Range
<b>Moral vs Legal Violations</b>				
Moral-not allowed	6/6	≥6	0.2	Normal Range
Moral-Severity	27/60	≥39	-2.8	Impaired
Moral-Rules	12/12	≥11	0.3	Normal Range
Conventional- not allowed	6/6	≥5	0.5	Normal Range
Conventional-Severity	13/60	≥20	-2.4	Severely Impaired
Conventional-Rules	11/12	≥6	0.8	Normal Range

to attribute emotions to other reflects the criteria A7 for narcissistic personality disorder (i.e., unable to recognize or identify with the feelings and needs of others); the lack of theory of mind is in line with the criteria A1 for paranoid personality disorder (i.e., suspect, without sufficient basis, that others are exploiting, harming or deceiving him), and so on.

## 2.6. The purpose of the brain imaging scan exam

In addition, a structural brain magnetic resonance imaging (MRI) scan examination was requested by the defense. Despite previous literature did not incontrovertibly identify specific brain alterations in personality disorders, the consultants considered the defendant's personality disorder so severe that neuro-anatomical alterations reflecting the severity of personality disorder were expected to be found. Indeed, literature consensually identified brain alterations in psychiatric disorders [37–41], which have been for long time considered functional disorders, i.e., devoid of any identifiable structural alteration. We believe that this gap should now be overcome, as it is now known that the distinction between "organic" and "functional" disorder merely reflects the sophistication of the methodology we use to study them [42]: organic disorder are characterized by brain abnormalities clearly evident

almost by naked eyes, while functional disorders are characterized by brain abnormalities discovered through statistical analysis of the data. In this context, the defense consultant's strongly believed it would have been possible to identify a neural signature reflecting the peculiar clinical phenomenology manifested by the defendant. In accordance with authoritative literature, they intended to test the hypothesis that the structure of key brain regions for psychiatric disorders may be altered in the defendant. These key regions are identified in the cingulate cortex [37,43,44], insula [37,43,44] and putamen [37,45], being these regions known to be similarly affected across distinct psychiatric disorders.

Thus, a brain MRI scan was acquired using a high-resolution MR scanner and analyzed using the Voxel Based Morphometry –VBM-[46–49] pipeline. Importantly, contrary to psychiatric symptoms, VBM results cannot be malingered by the defendant, making the obtained results by far less prone than clinical interview to subjectivity. Critically, a map of distribution of false positives is available for VBM [50] when it is applied to single case analysis [51,52], thus the error rate is quantifiable for each brain region.

Importantly, the MRI scan examination was not requested to make a diagnosis of personality disorder, that had already been made clinically by the defense consultants, but to reduce the ongoing controversies on the distinction between personality trait (i.e., normal personality) and personality disorder (i.e., psychopathology). In other words, the MRI scan was obtained to support or not the presence of psychopathology, regardless of the nosographic categorization, that in this case would have been impossible, as a neural signature for narcissistic personality disorder does not exist or it is still unknown. This approach, that clearly is research and hypothesis driven, may improve the forensic assessment by adding a significant *quid plus* to reduce subjectivity in insanity assessment [27].

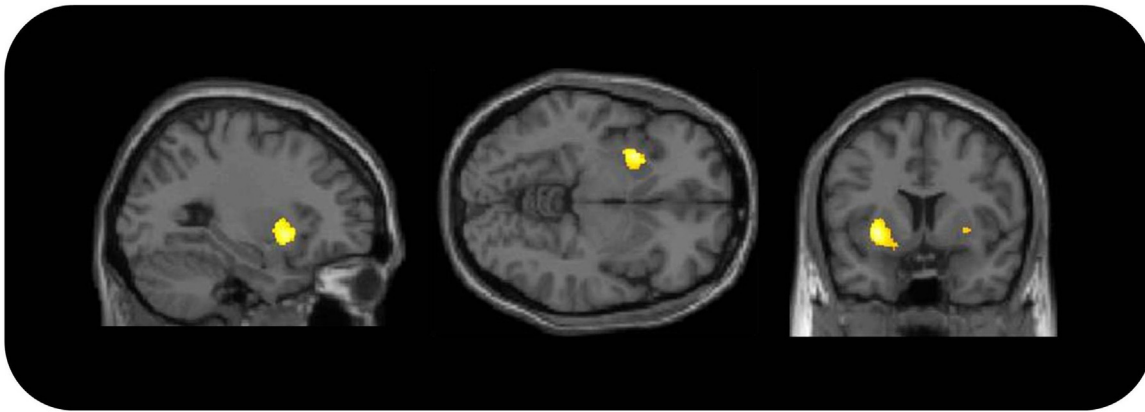
## 2.7. The relevance/meaning of the MRI findings

The defendant brain showed a bilaterally increased gray matter volume in the putamen, as compared with the brains from 24 gender and age matched healthy controls (see Fig. 1). Despite the finding of an increased grey matter volume (rather than decrease) might seem *prima facie* to be counterintuitive, the medical literature is rich of examples were the increased of biological material is coupled with intellectual disability. For instance: Down syndrome; macrocephaly; polygyria; etc.

The MRI finding is relevant for two main reasons.

First, according with the published errors probability distribution map in single case VBM, the probability to find false positives (i.e. statistical errors) in the putamen is very low (3% and 2% for left and right putamen, respectively [51]). This denotes a high specificity of the results, meaning that it would be very unlikely to find a neuroanatomical alteration in the putamen in healthy individuals (i.e., in individuals free from psychopathological disorders). The high specificity of this result is particularly relevant in the current case, as it significantly increases the likelihood that the neuroanatomical alteration in the putamen reflects a clinically relevant abnormality, rather than an incidental finding.

Second, an increased grey matter volume in the putamen has recently attracted interest as a trans-diagnostic feature in psychiatric disorders [37,45]. In other words, an increased volume in the putamen has been observed across many distinct psychiatric disorders. Thus, the high specificity of this result, even though it did not contribute to the nosographic categorization of the psychiatric disorder, clearly corroborate the diagnostic hypothesis of the defense consultants, providing an indirect and independent support to the presence of a mental disorder in the defendant. Importantly, it is already known that brain MRI results alone could not be used for diagnostic purposes, for which the clinical



**Fig. 1.** Neuroanatomical abnormalities in the defendant compared to a healthy control group. Yellow indicates increased grey matter volume in the defendant's brain as compared to controls. Abnormalities were located in the left putamen (MNI coordinates: -30, 8, -3). False positives have a 3% probability of being located in this region. Statistical threshold:  $p < 0.05$  Family Wise Error correction for multiple comparisons (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.).

assessment is essential. In this case, however, the different parts disagree only on the psychopathological meaning of the clinical findings (bias at the level of the conclusions [14]).

The logical reasoning is straightforward and is the following:

- All the parts (*Periti* and defense consultants) agreed on the presence of narcissistic personality features, meaning that narcissistic features were clinically evident.
- The parts, however, disagreed on the clinical meaning of these symptoms: according to the *Periti*, the defendant personality traits were not severe enough to be classified as psychopathological features while, according to the defense consultants, the symptoms were severe and clearly indicative of a psychopathological condition of clinical relevance, specifically a personality disorder. This different interpretation clearly denotes the presence of bias at the level of conclusions [14].
- Moreover, the defence consultants judged the personality disorder to be very severe. For this reason, following a scientific and hypothesis driven approach based on the evidence of neuroanatomical alterations in psychiatric disorders, they asked that a structural brain MRI be acquired.
- A neuroanatomical alteration characterized by high specificity for psychopathology was found in the defendant's brain.
- This result was an indirect support to the presence of psychopathology, but did not help in the nosographic categorization of the psychopathology.
- The nosographic categorization was clinically clear, as all the experts agreed on the presence of narcissistic features.

## 2.8. *Periti* comments to the multidisciplinary assessment results

In the first place, it is important to underline that for the clinical psychiatric assessment, between the unstructured interview with a lower accuracy and the structured interview with a higher accuracy [6–9], the *Periti* selected the less accurate methodology.

Regarding the results from the psychopathological and neuropsychological assessments, the judge experts dismissed the data, affirming that they could not be trusted as they were not in line with the results from the clinical observation. This procedure appears to be quite peculiar, to say the least, from a methodological point of view in the first place. Either a test is valid or it is not valid. If a given test is valid and accepted by the scientific community, then the results of the test must be taken into consideration independently from any other consideration, *in*

*primis* from the observer's expectations. Results of a test, be it a psychometric one or blood tests, are used to corroborate or to dismiss a diagnostic hypothesis, not the other way around. That is, to dismiss the usefulness of a test if the results do not fit with one own's hypothesis. As a matter of fact, in this specific case, the results from the psychopathological and neuropsychological testing were perfectly in line with the clinical observations as well as with the interpretation provided by the defense consultants. Thus, these objective measures did corroborate the diagnostic hypothesis proposed by the defense consultants while disproving the *Periti* hypothesis. Furthermore, the *Periti* replied that the defense's consultants were providing a "test based" diagnosis. In other words, they affirmed that the diagnosis of a personality disorder formulated by the defense, as opposed to their conclusion of mere personality traits, was grounded in the test results only. They also said that the proof that tests were unreliable laid in the fact that the MMPI-2 failed to identify paraphilic tendencies in the defendant. This reasoning is clearly biased as: i) the MMPI-2 does not include a subscale to measure paraphilia, thus it cannot identify something it has not been thought for; ii) they never talked about paraphilia before; iii) the Hendrick Sexual attitude scale they applied also did not reveal anything anomalous in the sexual attitudes of the defendant, so it is not clear why this should be a problem for the MMPI-2 but not for the questionnaire they chose.

The judge experts were clearly biased by a *confirmatory logic*, a logical bias that is known to be widely present in the forensic context [11,15,17]. Contrary to the methodological principles explained above, according to the *confirmatory logic* they considered the test valid and relevant if the results were in accordance with their diagnosis, while they considered the test not valid and irrelevant if the results were not in accordance with their diagnosis. For example, they considered relevant the results from the Hendrick Sexual Attitudes Scale [29], a self report questionnaire that is devoid of internal indices of malingering, that revealed a normal sexual habits in the defendant, a result that is confuted by and is in striking contrast with the criminal acts that he committed. On the contrary, they considered unreliable the results from the MMPI-2 and the MCMI-III.

With respect to the MRI scan exam results, the *Periti* replied that the current guidelines do not recommend brain scans for the diagnosis of any psychiatric disorder. While we do agree that this statement is correct, we do also believe that their reply is biased by the *strawman fallacy*, consisting in the substitution of a person's position or argument with a distorted, exaggerated or

misinterpreted version of the position or of the argument [53]. Indeed, the defense consultants never said they were using MRI for diagnostic purposes, as their diagnosis was based on the clinical evaluation, including the psychiatric interview and the psychopathological and neuropsychological assessments. However, the forensic controversy between the presence or absence of a psychopathological condition could not be disentangled using the pieces of information collected by the clinical interview, as these were subjected to different interpretations. The defense consultants judged the clinical symptoms manifested by the defendant very severe and, according with the most authoritative literature [37,38], they postulated that this severe condition should have a brain signature in regions relevant for psychopathology. For this reason, using a hypothesis driven approach, the defense consultants asked for an brain MRI scan to be performed. The MRI results supported the presence of psychopathology, providing a more concrete and objective piece of evidence and enriched the forensic assessment with a knowledge that would never be reached with the clinical assessment only. Indeed, not only the MRI scan revealed a neuroanatomical alteration characterized by a high specificity within the defendant brain, but this alteration was also located in brain regions emerging as a trans-diagnostic brain signature for psychiatric illness [37,45]. Although MRI results cannot be of help yet in the nosographic categorization of psychopathology, the clinical features clearly pointed toward a narcissistic personality picture, as consensually agreed by the *Periti* and the defense consultants. Indeed, as discussed above, the divergence was on the entity and the clinical relevance of the narcissistic features, not on their qualitative aspects.

### 3. Critical discussion

In this paper, we described a real criminal case in which the defendant was charged with sexual abuses, as he sexually abused unconscious patients, regardless of their gender or age. An insanity evaluation was then requested.

This case clearly highlights that a psychiatric assessment based on clinical interviews is necessary but may be not sufficient for the evaluation of insanity, even if some preliminary instruments might help [54]. Indeed, the very same anamnestic/clinical profile may be, and was, interpreted in different ways by different experts. This result is in accordance with previous literature reporting low inter-rater concordance in psychiatric diagnoses [8–10] and with literature indicating the presence of relevant cognitive biases in the forensic setting [11,14–17,19,22,23]. Furthermore, we have also identified the presence of at least two logical fallacies, namely the *confirmation bias* [15] and the *strawman fallacy* [17], in the *Periti* reasoning, that heavily influenced their reasoning and, in our opinion, their conclusions.

In this paper, we propose the introduction of an integrated and multidisciplinary evaluation as a way to minimize subjectivity, reduce controversies and increase inter-subject concordance in insanity assessment evaluations [27,55]. In particular, in this case, the introduction of psychopathological and neuropsychological assessments was requested, as well as the analysis of brain structure by a MRI scan exam. The introduction of this methodology decreases the potential risk of errors, as it drastically reduces the possibility of cognitive biases at the “level of the observations” [12,14]. This terminology refers to the Hierarchy of Expert Performance – HEP- applied to the forensic psychological assessment [14], a model that describes cognitive biases potentially emerging within and between experts. The HEP distinguished errors emerging both at the level of observations and at the level of conclusions. According to HEP, the “level of observations” refers to the different performance in actually making the original observation. In other words, it refers to

different abilities of clinicians to observe, to detect the patient's symptoms. For instance, if three clinicians describe different symptoms in the same patients, this is clearly indicative of bias at the level of observations. In this case, being MRI analysis through VBM automatic, the possibility to observe different results is virtually absent, thus reducing the potential bias at the level of the observations.

According to HEP, the “level of conclusions” refers instead to the assessment and the interpretation of observations. For instance, if two clinicians observe the same symptoms but give a different interpretation of these symptoms, then a bias at the level of the conclusion is present. In the current case report, a bias at the level of the conclusions is clearly evident as, based on the same symptoms, the two panels of experts reached different diagnostic conclusions, with radically different implications on insanity.

To date, forensic psychiatry is highly prone to biases both at the level of the observations and at the level of the conclusions [11,14]. The adoption of a multi-disciplinary and integrated approach that includes unstructured clinical interview, structured clinical interview, psychopathological assessment and neuropsychological evaluation will ensure an important reduction of biases at the level of the observation [27]. Indeed, in a case when controversies between the two forensic sides emerge, for instance, on lack of empathy of the defendant, the neuropsychological evaluation will disentangle the controversies providing clear and objective data supporting the opinion of one of the two sides. The forensic discussion on insanity will then be focused on the impact of this deficit on insanity (level of the conclusion).

The case described in the current paper is interesting as the main controversy between the *Periti* and the defense consultants laid on the distinction between personality traits and personality disorder. Indeed, while the *Periti* interpreted the defendant's behavioral peculiarities merely as personality traits, the defense consultants sustained that these peculiarities fully qualified as a personality disorder. Thus, in a wider perspective, as there is no reliable way to clinically disentangle this diatribe, the judge eventually will end up with two contrasting opinions and, because of the lack of the necessary scientific knowledge, most of the times he will be unable to reach a decision “beyond any reasonable doubt”.

Critically, the introduction of an integrated multidisciplinary approach may end this controversy. As a matter of fact, in this specific case, the neuropsychological, psychopathological and imaging data, being not subjected to interpretative variability, consistently indicated the presence of a clinically defined psychopathology (Fig. 2). Indeed, they revealed that the defendant had above threshold features for a personality disorder, a defective theory of mind, an impaired ability to attribute emotions to others and difficulties in judging the severity of behavioral violations. Furthermore, the presence of brain abnormalities characterized by a high specificity corroborated the presence of a significant psychopathology. Thus, the introduction of a trans-disciplinary approach indicated the presence of psychopathology that could not be denied without introducing logical fallacies. The forensic discussion should then be focused on the impact of this significant psychopathology on insanity (level of conclusion).

In the current case, we have described how every piece of trans-disciplinary evidence was discharged by the *Periti* on the basis of logical fallacies, leaving their opinion on insanity merely based on the information from unstructured clinical interview, a highly unreliable methodology (53 % of accuracy [8,9]). As the scientific community is still devoid of a methodology characterized by a 100 % accuracy, it is of the utmost importance to adopt a multidisciplinary integrated approach that relies on the implementation of objective techniques (meaning that “bias at the level of the observations” are not possible, applying the HEP



**Fig. 2.** Schematic representation of the proposed approach. In the upper panel, the insanity evaluation using unstructured psychiatric interview alone has a high probability to be inconclusive, as in the current case. On the contrary, the introduction of an integrated multidisciplinary evaluation, including at least psychopathological and neuropsychological assessment and brain MRI scan exam when needed, may provide convergent pieces of evidence indicating the presence of psychopathology, as in this specific case.

terminology [14]) that are helpful to reduce the degree of potential error minimizing subjective interpretation of data. Even if the techniques applied will not be 100 % accurate, if they results will converge in support of the same diagnostic hypothesis, then the result of insanity evaluation can be considered reliable. We thus suggest that unstructured interview should be considered the necessary but not sufficient starting point for insanity assessment: it is pivotal to formulate a diagnostic hypothesis that should then be corroborated by further multidisciplinary assessment [27]. Of course, this multidisciplinary approach will not solve the problem of the low reliability and biases within each single discipline.

Finally, regarding the use of MRI data, its utilization in criminal trials has been widely criticized [56–58]. One of the main criticisms to this approach is that neuroimaging techniques, as VBM, are usually applied to compare groups of individuals, while in criminal cases inferences need to be made at the level of the single individual. According with this criticism, thus, the group to individual inference is particularly problematic. However, there are three main reasons why this potential criticism is not scientifically grounded. First, single case VBM is largely applied in clinical contexts (see [49] for a review) thus denoting that this technique is accepted within the scientific community. This technique is indeed useful to identify robust brain abnormalities in psychiatric disorders [39]. These abnormalities might also be trans-diagnostic [45,59] and/or trans-ethnic [43], denoting their consistency across different samples. In the clinical setting, single case neuroimaging is increasingly being applied to improve precision medicine in psychiatry [60]. Furthermore, legal criteria (Daubert criteria and their Italian equivalent-Cozzini) require that the error for every technique be known, and for single case VBM this is the case [51,52]. Indeed, maps visually representing the distribution of false positives have been created. These maps clarify the potential error rate in each specific brain regions [51,52]. VBM thus fully complies with the Daubert criteria. Second, single case inference on neuroimaging data has been recently enhanced through the introduction of machine learning algorithms that easily allow inferences to be made at the level of the single individual, which is recognized by the automated algorithm as pathological or not [59,61–66], even when MRI images come from different scanners [67]. Third, clinical tools that perform automatic analysis of individuals brain scans aiming to support clinical diagnosis

recently have been developed (for a review of the available tools please see [68]). These tools allow the clinician/forensic consultant to upload the MRI of the patient/defendant in an online tool that, by applying sophisticated automated algorithms, identifies neuro-anatomical abnormalities as deviation from the average healthy brain. A detailed report is then sent to the clinician. These three issues incontrovertibly denote that the group to individual inference is possible and is widely accepted.

Importantly, in order to avoid cognitive fallacies at the level of the conclusions that may impact on the interpretation of results [12,14], the interpretation of neuroanatomical abnormalities should strictly follow the guidelines for results interpretation in the forensic settings [28] that posit the rules that needs to be respected: 1) neuroimaging results should always be coupled with clinical symptoms (but the criminal behavior itself cannot be considered a symptom); 2) it is not possible to infer the presence of psychopathology from brain scan results; 3) an anatomico-clinical correlation should be present for the results to be meaningful.

To summarize the potential usefulness of an integrated multidisciplinary assessment in criminal cases, it is worth highlighting that we agree that a test or MRI based diagnosis must be strictly avoided [28]. Indeed, to make a diagnosis based on test results only or on the presence of brain abnormality only, not coupled with clinical symptoms, would be a logical fallacy called reverse inference [69]. This is also clearly acknowledged in the guidelines for the correct interpretation of neuroimaging results [28]. On the contrary, in a case like the one described here, in which the clinical interview was inconclusive from a diagnostic perspective, an integrated multidisciplinary assessment can be crucial to disentangle whether or not psychopathology is present and is clinically relevant. Indeed, given that a multidisciplinary approach by definition provides independent pieces of evidence, if they coherently converge toward a diagnosis/opinion on sanity, it would become very difficult to sustain the opposite conclusion without falling into logical biases. Although test or MRI scan exam results taken individually and disjoint from clinical observations are meaningless, their use to complement the clinical psychiatric assessment could provide the judge with convergent evidence supporting or not the clinically based opinion of not guilty by reason of insanity. This is of critical relevance in criminal cases,

where judges have to hold someone responsible for the crime “beyond any reasonable doubt”.

As a final note, this manuscript emphasizes the lack of reliability in this discipline only between, inter-expert reliability, while we did not discuss the importance of within, intra-rater, reliability. Intra-rater reliability refers to the degree to which each expert reaches the same conclusion if considering the same data repeatedly, or when an identical case is presented within different contexts [14]. Forensic psychology research has almost exclusively focused on inter-rater agreement and has completely neglected researching intra-rater agreement. This topic is, indeed, very complicated when dealing with forensic psychiatry, as psychiatric symptoms can rapidly change over time, thus different intra-rater observations may be explained by different symptoms manifested by the defendant at different times, rather than by an intrinsic bias at the level of the observations (to use the HEP terminology [14]). Thus, it is very difficult to disentangle what really caused different observations. Clearly, different observations lead to different conclusions, potentially making intra-rater biases at the level of observations very impacting on conclusions. To determine whether and to what extent multidisciplinary assessment can contribute to reduce intra-rater biases, new studies should compare systematically inter-rater reliability when experts rate cases in which a multidisciplinary approach has or has not been adopted. The lack of discussion regarding the distinct potential biasing effects of inter- and intra-rater reliability represents a limitation of the current paper.

To sum up, the low accuracy of the interview based assessment of insanity, coupled with the permeating presence of logical fallacies, often makes insanity assessment to be an unreliable, subjective opinion that can result in arbitrary and unjust legal outcomes for the forensic examinee, as well as in diminishing confidence in psychological expertise within the legal system. The denial of this problem is a cognitive fallacy *per se*, called “denial logical bias” [11,16]. There is an urgent need to find a way to improve the reliability of insanity evaluation. The adoption of a trans-disciplinary neuroscientific approach that follows the convergence of evidence principle has been proposed as a strategy to achieve this aim [55,70]. While the application of a multidisciplinary evaluation will not solve the problem of the high rate of error within each single discipline, it is an imperfect solution to overcome the limitations intrinsic to each discipline and to mitigate the effect of these problems on insanity opinion. Therefore, research should decisively pursue the goal to decrease the error rate within each single discipline, clinical forensic psychiatry in the first place. Future research should extend to a large sample the evaluation of the impact of the adoption of this strategy on the inter-rater reliability of insanity assessment.

### Ethical standards

The patient described provided a written informed consent.

### CRediT authorship contribution statement

**Cristina Scarpazza:** Conceptualization, Funding acquisition, Investigation, Methodology, Writing - original draft. **Iaria Zampieri:** Writing - original draft. **Alessio Miolla:** Writing - original draft. **Giulia Melis:** Writing - original draft. **Pietro Pietrini:** Conceptualization, Supervision, Writing - review & editing. **Giuseppe Sartori:** Conceptualization, Supervision.

### Declaration of Competing Interest

The authors report no declarations of interest.

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### References

- [1] E.K. van Straalen, et al., The interpretation of forensic conclusions by criminal justice professionals: the same evidence interpreted differently, *Forensic Sci. Int.* 313 (2020) p. 110331.
- [2] B.D.W. Group, Biomarkers and surrogate endpoints: preferred definitions and conceptual framework, *Clin. Pharmacol. Ther.* 69 (3) (2001) 89–95.
- [3] R.H. Perlis, Translating biomarkers to clinical practice, *Mol. Psychiatry* 16 (11) (2011) 1076–1087.
- [4] D. Prata, A. Mechelli, S. Kapur, Clinically meaningful biomarkers for psychosis: a systematic and quantitative review, *Neurosci. Biobehav. Rev.* 45 (2014) 134–141.
- [5] B. Dubois, et al., Research criteria for the diagnosis of Alzheimer's disease: revising the NINCDS-ADRDA criteria, *Lancet Neurol.* 6 (8) (2007) 734–746.
- [6] A. Aboraya, et al., The reliability of psychiatric diagnosis revisited: the clinician's guide to improve the reliability of psychiatric diagnosis, *Psychiatry (Edgmont (Pa.: Township))* 3 (1) (2006) 41–50.
- [7] M. Chmielewski, et al., Method matters: understanding diagnostic reliability in DSM-IV and DSM-5, *J. Abnorm. Psychol.* 124 (3) (2015) 764–769.
- [8] P.R. Miller, Inpatient diagnostic assessments: 2. Interrater reliability and outcomes of structured vs. unstructured interviews, *Psychiatry Res.* 105 (3) (2001) 265–271.
- [9] P.R. Miller, et al., Inpatient diagnostic assessments: 1. Accuracy of structured vs. unstructured interviews, *Psychiatry Res.* 105 (3) (2001) 255–264.
- [10] D.A. Regier, et al., DSM-5 field trials in the United States and Canada, Part II: test-retest reliability of selected categorical diagnoses, *Am. J. Psychiatry* 170 (1) (2013) 59–70.
- [11] H. Ditrich, Cognitive fallacies and criminal investigations, *Sci. Justice* 55 (2) (2015) 155–159.
- [12] I.E. Dror, A hierarchy of expert performance, *J. Appl. Res. Mem. Cogn.* 5 (2016) 121–127.
- [13] I.E. Dror, Human expert performance in forensic decision making: seven different sources of bias, *Aust. J. Forensic Sci.* 49 (5) (2017) 541–547.
- [14] I.E. Dror, D.C. Murrrie, A hierarchy of expert performance applied to forensic psychological assessments, *Psychol. Public Policy Law* 5 (2017) 1–13.
- [15] S.M. Kassir, I.E. Dror, J. Kukucka, The forensic confirmation bias: problems, perspectives, and proposed solutions, *J. Appl. Res. Mem. Cogn.* 2 (2013) 42–52.
- [16] J. Kukucka, et al., Cognitive bias and blindness: a global survey of forensic examiners, *J. Appl. Res. Mem. Cogn.* 6 (2017) 452–459.
- [17] G.S. Cooper, V. Meterko, Cognitive bias research in forensic science: a systematic review, *Forensic Sci. Int.* 297 (2019) 35–46.
- [18] I.E. Dror, D. Charlton, A.E. Peron, Contextual information renders experts vulnerable to making erroneous identifications, *Forensic Sci. Int.* 156 (1) (2006) 74–78.
- [19] I.E. Dror, Cognitive and human factors in expert decision making: six fallacies and the eight sources of bias, *Anal. Chem.* 92 (12) (2020) 7998–8004.
- [20] M.A. Guarnera, D.C. Murrrie, M.T. Boccaccini, Why do forensic experts disagree? Sources of unreliability and Bias in forensic psychology evaluations, *Transl. Issues Psychol. Sci.* 3 (2) (2017) 143–152.
- [21] I. Melle, The Breivik case and what psychiatrists can learn from it, *World Psychiatry* 12 (1) (2013) 16–21.
- [22] D.C. Murrrie, et al., Are forensic experts biased by the side that retained them? *Psychol. Sci.* 24 (10) (2013) 1889–1897.
- [23] L.A. Guarnera, D.C. Murrrie, M.T. Boccaccini, Why do forensic experts disagree? Sources of unreliability and Bias in forensic psychology evaluations, *Transl. Issues Psychol. Sci.* 3 (2) (2017) 143–152.
- [24] W.N. Gowensmith, D.C. Murrrie, M.T. Boccaccini, How reliable are forensic evaluations of legal sanity? *Law Hum. Behav.* 37 (2) (2013) 98–106.
- [25] M.A. Guarnera, D.C. Murrrie, Field reliability of competency and sanity opinions: a systematic review and meta-analysis, *Psychol. Assess.* 29 (6) (2017) 795–818.
- [26] D. Meuwly, D. Ramos, R. Haraksim, A guideline for the validation of likelihood ratio methods used for forensic evidence evaluation, *Forensic Sci. Int.* 276 (2017) 142–153.
- [27] G. Sartori, G. Orrù, C. Scarpazza, The methodology of forensic neuroscience, *Neuroscience and Law: Complicated Crossings and New Perspectives*, (2020), pp. 453–473.
- [28] C. Scarpazza, et al., The charm of structural neuroimaging in insanity evaluations: guidelines to avoid misinterpretation of the findings, *Transl. Psychiatry* 8 (1) (2018) 227.



- [29] C. Hendrick, S.S. Hendrick, D.A. Reich, The brief sexual attitudes scale, *J. Sex Res.* 43 (1) (2006) 76–86.
- [30] J.N. Butcher, et al., *MMPI-2: Minnesota Multiphasic Personality Inventory-2: Manual for Administration and Scoring*, University of Minnesota Press, Minneapolis, MN, 1989.
- [31] S.R. Hathaway, J.C. McKinley, M.R. Committee, *MMPI-2: Minnesota Multiphasic Personality Inventory-2: Manual for Administration and Scoring*, University of Minnesota Press, 1989.
- [32] P. Pancheri, S. Sirigatti, *MMPI-2 Minnesota Multiphasic Personality Inventory-2 Manual. Italian Adaptation, OS (Organizzazioni Speciali)*, Florence, Italy, 1995.
- [33] R. Harris, J. Lingo, Subscales for the Minnesota Multiphasic Personality Inventory, *Mimeographed Materials*, The Langley Porter Clinic, 1968.
- [34] T. Millon, in: A. Zennaro, S. Ferracuti, M. Lang, E. Sanavio, O.S. Giunti (Eds.), *MCMI-III Millon Clinical Multiaxial Inventory –III Manuale*, Organizzazioni Speciali, Firenze, 1997 Ed. Ital. a cura di.
- [35] T. Millon, *Manual for the MCMI-II, 2nd edition*, National Computer Systems, Minneapolis, MN, 1987.
- [36] M. Prior, G. Sartori, S. Marchi, *Cognizione sociale e comportamento vol. 1 Uno strumento per la misurazione*, UPSEL Domeneghini, 2003.
- [37] M. Goodkind, et al., Identification of a common neurobiological substrate for mental illness, *JAMA Psychiatry* 72 (4) (2015) 305–315.
- [38] N. Opel, et al., Cross-disorder analysis of brain structural abnormalities in six major psychiatric disorders: a secondary analysis of mega- and meta-analytical findings from the ENIGMA consortium, *Biol. Psychiatry* (2020).
- [39] S. Vieira, et al., Neuroanatomical abnormalities in first-episode psychosis across independent samples: a multi-centre mega-analysis, *Psychol. Med.* (2019) 1–11.
- [40] C. Zhuo, et al., A unified model of shared brain structural alterations in patients with different mental disorders who experience own-thought auditory verbal hallucinations—a pilot study, *Brain Behav.* 10 (6) (2020) p. e01614.
- [41] S.E. Morgan, et al., Functional magnetic resonance imaging connectivity accurately distinguishes cases with psychotic disorders from healthy controls, based on cortical features associated with brain network development, *Biol. Psychiatry Cogn. Neurosci. Neuroimaging* 9022 (20) (2020) p. 30138–5.
- [42] P. Pietrini, *Toward a biochemistry of mind?* *Am. J. Psychiatry* 160 (11) (2003) 1907–1908.
- [43] Q. Gong, et al., A neuroanatomical signature for schizophrenia across different ethnic groups, *Schizophr. Bull.* 41 (6) (2015) 1266–1275.
- [44] T. Wise, et al., Common and distinct patterns of grey-matter volume alteration in major depression and bipolar disorder: evidence from voxel-based meta-analysis, *Mol. Psychiatry* 22 (10) (2017) 1455–1463.
- [45] Q. Gong, et al., A transdiagnostic neuroanatomical signature of psychiatric illness, *Neuropsychopharmacology* 44 (5) (2019) 869–875.
- [46] J. Ashburner, K.J. Friston, *Voxel-based morphometry—the methods*, *Neuroimage* 11 (6 Pt 1) (2000) 805–821.
- [47] J. Ashburner, K.J. Friston, *Why voxel-based morphometry should be used*, *Neuroimage* 14 (6) (2001) 1238–1243.
- [48] C.D. Good, et al., *A voxel-based morphometric study of ageing in 465 normal adult human brains*, *Neuroimage* 14 (1 Pt 1) (2001) 21–36.
- [49] C. Scarpazza, M.S. De Simone, *Voxel-based morphometry: current perspectives*, *Neurosci. Neuroecon.* 5 (2016) 19–35.
- [50] C. Scarpazza, et al., *False positive rates in Voxel-based Morphometry studies of the human brain: should we be worried?* *Neurosci. Biobehav. Rev.* 52 (2015) 49–55.
- [51] C. Scarpazza, et al., *When the single matters more than the group: very high false positive rates in single case Voxel based Morphometry*, *Neuroimage* 70 (2013) 175–188.
- [52] C. Scarpazza, et al., *When the single matters more than the group (II): addressing the problem of high false positive rates in single case voxel based morphometry using non-parametric statistics*, *Front. Neurosci.* 10 (2016) 6.
- [53] C. Scarpazza, et al., *The role of neuroscience in the evaluation of mental insanity: on the controversies in Italy: comment on “on the stand. Another episode of neuroscience and law discussion from Italy*, *Neuroethics* 11 (1) (2018) 83–95.
- [54] W. Cai, et al., *The reliability and validity of the rating scale of criminal responsibility for mentally disordered offenders*, *Forensic Sci. Int.* 236 (2014) 146–150.
- [55] C. Scarpazza, A. Pennati, G. Sartori, *Mental insanity assessment of pedophilia: the importance of the trans-disciplinary approach. Reflections on two cases*, *Front. Neurosci.* 12 (2018) 335.
- [56] M.J. Vitacco, et al., *The limited relevance of neuroimaging in insanity evaluations*, *Neuroethics* (2020).
- [57] A. Bigenwald, V. Chambon, *Criminal responsibility and neuroscience: no revolution yet*, *Front. Psychol.* 10 (2019) 1406.
- [58] S.J. Morse, in: Ezra E.H. Griffith (Ed.), *Neuroscience in Forensic Contexts: Ethical Concerns Ethics Challenges in Forensic Psychiatry and Psychology Practice*, 2018, pp. 132–158.
- [59] E.M.J. Silveira, et al., *Decoding rumination: a machine learning approach to a transdiagnostic sample of outpatients with anxiety, mood and psychotic disorders*, *J. Psychiatr. Res.* 121 (2020) 207–213.
- [60] S. Tognin, et al., *Towards precision medicine in psychosis: benefits and challenges of multimodal multicenter studies-PSYSCAN: translating neuroimaging findings from research into clinical practice*, *Schizophr. Bull.* 46 (2) (2020) 432–441.
- [61] D. Lei, et al., *Detecting schizophrenia at the level of the individual: relative diagnostic value of whole-brain images, connectome-wide functional connectivity and graph-based metrics*, *Psychol. Med.* (2019) 1–10.
- [62] D. Lei, et al., *Integrating machine learning and multimodal neuroimaging to detect schizophrenia at the level of the individual*, *Hum. Brain Mapp.* (2019).
- [63] S. Vieira, et al., *Using machine learning and structural neuroimaging to detect first episode psychosis: reconsidering the evidence*, *Schizophr. Bull.* 46 (1) (2020) 17–26.
- [64] G.B. Chand, et al., *Two distinct neuroanatomical subtypes of schizophrenia revealed using machine learning*, *Brain* (2020).
- [65] A. Mechelli, S. Vieira, *From models to tools: clinical translation of machine learning studies in psychosis*, *NPJ Schizophr.* 6 (1) (2020) 4.
- [66] S.E. Morgan, et al., *Cortical patterning of abnormal morphometric similarity in psychosis is associated with brain expression of schizophrenia-related genes*, *Proc. Natl. Acad. Sci. U. S. A.* 116 (19) (2019) 9604–9609.
- [67] R. Garcia-Dias, et al., *Neuroharmony: a new tool for harmonizing volumetric MRI data from unseen scanners*, *NeuroImage* 220 (2020) p. 117127.
- [68] C. Scarpazza, et al., *Translating research findings into clinical practice: a systematic and critical review of neuroimaging-based clinical tools for brain disorders*, *Transl. Psychiatry* 10 (1) (2020) 107.
- [69] R.A. Poldrack, *Can cognitive processes be inferred from neuroimaging data?* *Trends Cogn. Sci.* 10 (2) (2006) 59–63.
- [70] G. Sartori, S. Pellegrini, A. Mechelli, *Forensic neurosciences: from basic research to applications and pitfalls*, *Curr. Opin. Neurol.* 24 (4) (2011) 371–377.