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Deception in Court

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ABSTRACT

Deception in Court

Different forms of deception can be applied to hide one's true intentions; this faking can take various forms, depending on the deceiver's aim(s): faking bad or faking good. Since 25-45% of behaviors are deceptive in a legal setting, detecting these efforts has become a priority. With this aim, the development of objective and effective tools has increased considerably.
Starting with the first polygraph created by Vittorio Benussi in 1914 to nowadays through the implementation of Artificial Intelligence, we will explore the lie detection techniques that have followed over the years.

Keywords: Lie - Court - Lie detection

Malingering in forensic settings

Everybody lies. Cops lie. Lawyers lie. Witnesses lie. The victims lie. A trial is a contest of lies. And everybody in the courtroom knows this. The judge knows this. Even the jury knows this. They come into the building knowing they will be lied to. They take their seats in the box and agree to be lied to.

(Michael Connelly, 2008)

Definition and prevalence

"Everybody lies", to a greater or lesser degree, is the assumption many people come to, and at the root of who we are (or are not) about others, there is often decep-

tion. Hence, any moral, ethical, or legal system should consider this fundamental feature of human nature[1].

Based on evolutionary and psychosocial studies, lying is a strategy used by animals to survive in an environment with limited resources; consider, for example, the behavior of imitation or camouflage with the environment that the animals carry out to avoid being victims of predators[2].

According to many, lying has been deeply embedded in all societies since ancient times, so deeply ingrained that some argue that our brains are programmed to deceive. Children just two years old are perfectly capable of telling lies to deny a behavior they know to be incorrect; however, they should wait 4 or 5 years to make these lies more credible and consistent[3]. Adults, instead, say three lies every ten minutes and in one out of three social situations[4]. Without exaggeration, people lie at least once or twice a day: 80% of these lies are in part about the person telling them, and two-thirds of them benefit the liar more than other people[5].

In 2009 Abe[6] defined deception as a psychological process by which one individual deliberately attempts to convince another person to accept as true what the liar knows to be false, typically for the liar, or sometimes for others, to gain some type of benefit or to avoid loss. Also, Luigi Anolli[7] reviewed the anthropological, psychological, and social literature to deepen how pervasive lying is in humans.

Although there is no universal definition, many consider lying an on-off process, where there is lying, or there is not. On the contrary, lying is a continuous variable that is constantly influenced by the social situation, the strategies adopted, the degree of awareness, the motivations of the deceiver, and more[8]. In short, "everybody lies", and this attitude can be considered a widespread phenomenon in everyday life. It is easy to see how, in many occasions, given the appropriate reasoning and social skills, the rewards of deception can outweigh the costs associated with its discovery: producing a lie requires more mental resources than simply stating the truth, but if it enables the liar to achieve something highly sought then their efforts will be compensated.

Believing malingering is a modern era invention is incorrect. We have a way of reconstructing how simulation was one of the most adopted modes in the 2nd century CE or the Greco-Roman and Renaissance periods; Odysseus himself feigned mental illness to avoid the Trojan war, pretending to be a farmer and not recognizing his friends. Also the physician Galeno recorded a second example of malingering in Roman times. In a short pamphlet entitled *Quomodo morbum simulantes sint deprehendendi*[9], Galeno reported the case of two patients who faked to be ill. In the first case, the patient faked colic to avoid a public meeting, while in the latter, the patient faked an injured knee to avoid accompanying his master on a long journey and staying at home with his partner. There have been many physical or mental faked illnesses throughout history, ranging from simulated psychopathology to amnesia. Famous for the latter reference is the Italian Case of the Collegno amnesic who malingered retrograde amnesia and spent

nearly a year in Collegno without a name[10] or that of Rudolph Hess, a Nazi hierarch who claimed not to remember his role in the Third Reich period during the Nuremberg trial. A group of psychiatrists examined Hess and concluded that his amnesia was genuine. Subsequently, he declared: "My memory is again in order. The reasons why I simulated loss of memory were tactical". Whether to avoid a call to arms, escape the death penalty, or avoid prison, simulation is an attractive solution to social, economic, and personal problems[11].

For sure, the legal setting is a context where malingering behaviors creep in, reaching 25-45% of faking attitudes[12]. Mittenberg and colleagues' work from 2002[13], one of the most cited sources, provides a survey of 388 members of the American Board of Clinical Neuropsychologists concerning the frequency of malingering in personal injury claims (30%), disability or worker's compensation (32%), criminal cases (22%), medical or psychiatric cases (22%). These results suggest that rates of probable malingering varied markedly depending on the presumptive diagnosis; moreover, it differed for civil and criminal cases.

However, estimating the prevalence of simulation is challenging for several reasons; first of all, it will always be an underestimation of the phenomenon since the percentage of successful fakers does not emerge, which, by definition, remains excluded from the statistics. However, faking remains a specific issue that should never be denied.

Based on the specific scenario of legal presentation and the form in which advantages and gains come, deception may take on various facets: a subject willing to deceive can report symptoms that, in reality, do not exist or can accentuate signs living in the past, which have faded. Generally, it can be of two types: the individual can exaggerate generic symptoms belonging to various psychopathological areas, such as anxiety or depression (generalized malingering), or symptoms related to a particular disease (specific malingering)[14].

Faking good and faking bad in forensic settings

One of the most helpful discriminations to mention is probably between fake-good and fake-bad. On the one hand, a subject may be interested in faking an organic/mental disorder or cognitive impairment in a civil or criminal setting to gain compensation or a reduction in legal penalty; this attitude is known as faking bad or malingering. On the other hand, the deceiver may also attempt to present a more desirable version of himself to hide inconvenient features that could disfavor him (e.g., in litigation for child custody in favor of the other parent); so-called faking good or dissimulation.

Regarding faking bad, DSM-5[15] defines malingering as "the intentional production of false or grossly exaggerated physical or psychological symptoms, motivated by external incentives. Under some circumstances, malingering may represent adaptive behavior, for example, feigning illness while a captive of the enemy during wartime".

When trying to spot deception, the expert must first ask himself whether the subject might be motivated to fake from the context, taking note of two key features:

a. the intentionality of the subject in the production of symptoms;
b. the presence of external incentives associated with the behavior.

Dissimulation, or faking good, is not mentioned in DMS-5 but can be described as the mirror of malingering: "the tendency to give positive self-description", "claiming improbable virtues and denying common human frailties"[16]. As malingering, fake good might be present in several forms, such as hiding or minimizing undesired characteristics and exaggerating or making up positive qualities to pursue a personal goal. In criminal law, faking good is frequent when evaluating social dangerousness. While in civil law, it is common when assessing driving skills in the renewal-license setting or when assessing parental skills in the child custody context. For example, in everyday life, faking good is frequent during a job interview, where the candidate wants to show a more desirable version of himself to increase the probability of obtaining the job.
Detecting these efforts has become a priority in the field, feeding growing activity to develop incrementally objective and efficacious tools. Despite its relevance, scientific literature, and instruments to identify dissimulation, are unfortunately limited and insufficient. Probably malingering behaviors obtained more research interest due to their welfare and social costs (e.g., insurance compensation).
Despite all the progress made in pursuit of this goal, it must be emphasized that no technique or tool can be considered entirely objective. Each of these strategies and techniques measures the behavior of an individual who is deliberately lying and is intent on doing so based on several factors that influence his behavior (cooperation, motivation, secondary gains, personality)[17]. Consequently, any results should be considered in probabilistic terms since malingering may only be sure a) when the malingerer is discovered while performing the psychic or physical function claimed to be impaired, and b) when he confesses[18].

Differential diagnosis

Similar to lying, but not deliberate as such, are certain forms of psychopathology. For malingering to be diagnosed, the following conditions must be ruled out systematically[19]:

- *Conversion disorder along with other manifestations of somatoform disorders*. A conversion disorder is a form of altered voluntary motor or sensory function in which clinical findings demonstrate incompatibility between the symptom and recognized medical or neurological conditions. It differs from malingering in that motivation is internal rather than external,

and intentionality is absent. In contrast, in malingering, intentionality is conscious.

- *Dissociative disorders*. It is possible for the individual affected by the dissociative disorder to report psychic symptoms that are not attributable to a recognizable cognitive deficit or cerebral dysfunction. Dissociative disorders are characterized by a loss of continuity in the typical integration of consciousness, identity, memory, perception, behavior, motor control.

  As opposed to conversion disorder, in dissociative disorders, symptoms are neuropsychological rather than physical. Also, in this case, the differential diagnosis for malingering requires ruling out intentionality.
- *Factitious disorder:* faking physical or psychological signs or symptoms or inducing injury or disease to himself to play the sick role, attaining all corollary advantages deriving from the potential benefits that society provides for the sick role[20]. The difference between factitious disorder and malingering is in motivation. In this case too, the external incentives are absent. Conclusions regarding motivation can be challenging; for this reason, when distinguishing between factitious disorders and malingering, the role of context and a well-documented evidence trail is essential. Moreover, in clinical practice, deception is considered rare, whereas is considered more common in specific legal contexts or when a patient attempts to evade punishment in the criminal justice system or gain something. On the contrary, factitious disorders are generally encountered in clinical settings[21].
- *Other diagnostic categories* are still used today in clinical and psychiatric-forensic traditions, ranging between descriptions of malingering, dissociative or somatoform conditions, and factitious disorders. Despite that, they lack a formalized and standardized definition. Due to their extensive use in the Italian forensic field, we now mention four of them:

1. *Münchhausen syndrome*. This term was coined to describe those cases, predominantly in male individuals, that feigned physical symptoms and disorders.

   In this case the aim is to perpetuate a pattern of hospital and care-related experiences, such as hospitalization, surgery, quarrelsome relationships with medical professionals.

   It is distinguishable from factitious disorder because it is adopted to address more chronic and severe manifestations, less prone to recovery and where symptoms are really auto-induced (with injury or medications) rather than

purely feigned or merely lamented.

2. *Münchhausen syndrome by proxy*. Similar to the Münchhausen syndrome, this term is applied to the more severe cases. However, in this syndrome, the symptoms are induced by the perpetrator to another person (the victim). This term is ambiguous and sometimes is used to malingering by proxy. Still, it differs from the latter because it is not motivated by external gains (e.g., keeping a son sick for financial gain).
3. *Ganser syndrome* is typically observed in carceral environments and was initially noticed in convicts awaiting execution who would manifest a generalized plunge in superior cognitive functioning (with severe amnesia, absurd speech, failed logical reasoning) with instead preserved understanding, orientation, and consciousness. These symptoms are interpreted as signs of a dissociative disorder due to a highly stressogenic situation.
4. *Compensation neurosis* describes an exaggeration of symptoms that occur due to the unique stressor of seeking legally awarded compensation[22].

   Motivation in these cases is primarily internal, coupled with a lesser degree of anticipation of secondary gain. The financial reward may be a part of the condition and may influence the course, but the overall pattern of symptoms is more than just the pursuit of money. Again, in malingering, exaggeration occurs solely or primarily for external incentives, while internal incentives in compensation neurosis are equal to or larger than external ones. Moreover, the diagnosis of compensation neurosis requires determining the conscious and unconscious motivation (frequently made in distinguishing factitious disorder from conversion disorder).

To sum up, the parameters to be taken into account are:

1. subject's conscious intentionality making psychic symptoms not based on a genuine dysfunction of the nervous system;
2. presence of external incentives[23].

In addition, malingering should be strongly suspected when any possible combination of these factors is presented: 1) symptoms occur in a medico-legal setting; 2) is noted a marked discrepancy between the individual's claimed impairment and the objective findings; 3) there is a lack in collaboration during the assessment and low compliance with the prescribed treatment regimen; 4) presence of antisocial personality disorder (*ibidem*).

In the forensic context, particularly in forensic neuropsychology, it is good practice to identify the conscious intentionality of the subject and the existence of external incentives. If in a clinical setting it is usual to go along with the symptoms that the

patient reports, instead, in the forensic context, it is crucial first to take into account the two points listed above. Considering these parameters help the clinician to become a wise expert. Depending on the form of simulation, intentionality may be absent or accentuated. The presence of consciousness about the planning of the disorder (challenging to ascertain) should be a criterion for identifying the symptoms of deception. Moreover, many times the external advantage may not be immediately recognizable. When doubt exists, it is essential to look in the case history for economic benefits that are not evident at first glance (*ibidem*).

Techniques to detect malingering in forensic settings

During recent years, several strategies have been developed for malingering detection, proving to be helpful in aid of the purpose; nevertheless, it continues to be a challenging issue for examiners[24]. Despite the belief that someone can be an expert in detecting lies, classification accuracy based on subjective impressions is markedly low: 62% accuracy for psychologists compared with 54% for student research participants; hence professionals would benefit of a scant 12% advantage over chance[25]. The idea that examiners could detect mental illness simulator based on their clinical experience is mistaken and unempirical. On the contrary, some studies state that psychologists and psychiatrists cannot accurately detect lies. A recent metanalysis highlights that the accuracy of deception judgment without any aid or training is approximately around 50%[26]. This level of accuracy has the same odds of provide a judgment by chance. Moreover, the accuracy level of experts, such as police officers, investigators, judges, or psychologists, ranges solely around 54%[27]. This evidence suggests that it is tough to assess malingering by relying on personal judgment and is often inadequate when merely based on the clinical interview.

The salience, intrusiveness, and challenge in detecting lies have led the scientific community to set up several methods as accurately as possible to reveal them. In the following paragraphs, we will deepen this theme by analyzing the tools used in the forensic context to reveal lies, starting with the first lie detector created by Vittorio Benussi in 1914 to the current day through the implementation of Artificial Intelligence.

Historical evolution of the methods

Over time, the first methods for detecting lies developed based on the disorder that was being simulated, such as psychiatric or cognitive disorder. In the case, for example, of faked psychiatric disorders, the literature of the late 1800s early 1900s reported applicable criteria for deception. Interesting work is that written by Roncoroni in 1987, who, through the study of some inmates in prisons, identifies four criteria that together would diagnose the simulation of mental illness: 1) anamnesis, 2) general anatomical

and physiological criteria, 3) general psychological criteria, and 4) specific criteria for individual mental illnesses[28].

One of the earliest methods reported by Zago and Disfonzo[29] is the 'cunning means', originally introduced by Ingegnieros[30]. Ingegnieros defines them as an adjunct to the examination of the subject and "the best psychological reagent to the simulation". It involved, for example, mentioning to the simulator a false symptom not manifested by him and seeing if, within a short time, it would be referred. In 1905, with *La Perizia Psichiatrico-Legale*, Cesare Lombroso argued that the general characteristic of simulation is the exaggeration of the symptoms that the simulator compares with those of a real subject harboring pathology[31]. It is precisely these symptoms that Lombroso focused on exposing the lie, making himself directly available to the judge to detect significant psychophysiological changes during interrogation[32]. As the years went by, tools were developed for precisely this function, such as the polygraph, introduced in 1914 by Vittorio Benussi and discussed later.

Regarding detecting faked cognitive disorder such as memory deficit, the first attempt to develop instruments capable of detecting a possible faked amnesia was born between the 1800s and 1900s. One of these is the Ziehen's Test, used to identify a simulator in a short-term memory task. This test is based on the principle that a simulation attempt should be considered if a person cannot complete a task that an actual patient with, for example, dementia, can do. Other techniques born in this period that will be later described are the 15 Rey Items Test and the Floor Effect. Alfredo Coppola also used these methods; he was one of the clinicians who evaluated the Collegno Amnesic case and the only one who diagnosed "malingered retrograde amnesia"[33].

A notable landmark in the literature on the subject arose in the late 1900s with the introduction of the criteria of the Slick criteria. Initially proposed in 1999 and later updated in 2013, the Slick and Sherman criteria are one of the main contributions to detecting malingering. In the original classification[34], the authors proposed guidelines for the framing of what the authors labeled "Simulated Neurocognitive Dysfunction" (Malingered Neurocognitive Dysfunction, MND)*: "the volitional exaggeration or fabrication of cognitive dysfunction for the purpose of obtaining substantial material gain or avoiding or escaping formal duty or responsibility"*. Slick and colleagues' classification included a breakdown of the MND into three subclasses, each of which is followed by its inclusion criteria:

Definite MND

This is indicated by the presence of clear and compelling evidence of volitional exaggeration or fabrication of cognitive dysfunction and the absence of plausible alternative explanations. The specific diagnostic criteria necessary for Definite MND are listed below:

1. Presence of a substantial external incentive [Criterion A]
2. Definite negative response bias [Criterion B1]
3. Behaviors meeting necessary criteria from group B are not fully accounted for by Psychiatric, Neurological, or Developmental Factors [Criterion D]

Probable MND

This is indicated by the presence of evidence strongly suggesting volitional exaggeration or fabrication of cognitive dysfunction and the absence of plausible alternative explanations. The specific diagnostic criteria necessary for Probable MND are listed below.

1. Presence of a substantial external incentive [Criterion A]
2. Two or more types of evidence from neuropsychological testing, excluding definite negative response bias [two or more of Criteria B2-B6]

Or

One type of evidence from neuropsychological testing, excluding definite negative response bias, and one or more types of evidence from Self-Report [one of Criteria B2-B6 and one or more of Criteria C1-C5]

3. Behaviors meeting necessary criteria from groups B and C are not fully accounted for by Psychiatric, Neurological, or Developmental Factors [Criterion D]

Possible MND

This is indicated by the presence of evidence suggesting volitional exaggeration or fabrication of cognitive dysfunction and the absence of plausible alternative explanations. Alternatively, possible MND is indicated by the presence of criteria necessary for Definite or Probable MND except that other primary etiologies cannot be ruled out. The specific diagnostic criteria for Possible MND are listed below:

1. Presence of a substantial external incentive [Criterion A]
2. Evidence from Self-Report [one or more of Criteria C1-C5]
3. Behaviors meeting necessary criteria from group C are not fully accounted for by Psychiatric, Neurological, or Developmental Factors [Criterion D]

Or

Criteria for Definite or Probable MND are met except for Criterion D (i.e., primary psychiatric, neurological, or developmental etiologies cannot be ruled out). In such cases, the alternate etiologies that cannot be ruled out should be specified.

Explanation of criteria

Criteria A: *Presence of a substantial external incentive* (At least one clearly identifiable and substantial external incentive for exaggeration or fabrication of symptoms is present at the time of examination).

Criteria B: *Evidence* of exaggeration or fabrication of cognitive dysfunction on neuropsychological tests, as demonstrated by at least one of the following.

1. Definite negative response bias. Below chance performance ($p < .05$) on one or more forced choice measures of cognitive function.
2. Probable response bias. Performance on one or more well-validated psychometric tests or indices designed to measure exaggeration or fabrication of cognitive deficits is consistent with feigning.
3. Discrepancy between test data and known patterns of brain functioning.
4. Discrepancy between test data and observed behavior.
5. Discrepancy between test data and reliable collateral reports.
6. Discrepancy between test data and documented background history.

Criteria C: *Evidence from Self-Report*

1. Self-reported history is discrepant with documented history.
2. Self-reported symptoms are discrepant with known patterns of brain functioning.
3. Self-reported symptoms are discrepant with behavioral observations.
4. Self-reported symptoms are discrepant with information obtained from collateral informants.
5. Evidence of exaggerated or fabricated psychological dysfunction.

Criteria D: *Behaviors meeting necessary criteria from groups B or C are not fully accounted for by Psychiatric, Neurological, or Developmental Factors.*

In the following years, an intense debate was generated regarding critical issues concerned three main aspects of Slick's criteria: I) the concept of "diagnosis" of neurocognitive simulation, II) the use of forced-choice tests as a test to determine symptom validity, III) whether and how to inform the patient of the presence of such tests in the neuropsychological evaluation[35]. The critical issues raised led to a vibrant discussion among research groups dealing with simulation, which led the authors to update and revise the criteria originally proposed[36]. The first change made is the tripartition of the *Malingered Neuropsychological Dysfunction* in Primary MND, Secondary MND (definite and probable), and MND by Proxy (definite and probable). Below is the updated list of inclusion criteria.

Primary MND

Definite

1. Presence of a substantial external incentive for exaggeration/fabrication of symptoms (Criterion 1).
2. One or more very strong indicators of exaggeration/fabrication of neuropsychological problems or deficits (one or more of Criteria 2.0–2.3).
3. Behaviors meeting necessary criteria are not substantially accounted for by psychiatric, neurological, or developmental factors.

Probable

1. Presence of a substantial external incentive for exaggeration/fabrication of symptoms (medical-legal secondary gain).
2. Three or more indicators of possible exaggeration/fabrication of neuropsychological problems or deficits (three or more of Criteria 3.1–3.7).

Secondary MND (definite and probable)

Criteria for definite or probable MND are otherwise met, but there are compelling grounds to believe that at the time of assessment, the examinee did not have the cognitive capacity to understand the moral/ethical/legal implications of his or her behavior and/or was unable to control his or her behavior, secondary to immaturity (i.e., in childhood) or bona fide developmental, psychiatric, or neurological disorders or injuries of at least moderate severity. Secondary malingering cannot be diagnosed in persons with mild conditions such as MTBI.

MND by proxy (definite and probable)

Criteria for definite or probable MND are otherwise met, but there are compelling grounds to believe that a vulnerable examinee acted primarily under the guidance, direction, influence, or control of another individual. Examinees may be vulnerable to the influence of others by virtue of immaturity, neurodevelopmental and cognitive disabilities, and psychiatric illness, or by perceived inability to escape or avoid substantial coercion such as threats of physical harm for failure to behave as directed.

Specific criteria

1. Presence of a substantial external incentive for exaggeration/fabrication of symptoms (medical-legal secondary gain).

2. Very strong indicators of exaggeration/fabrication of neuropsychological problems or deficits.
2.1. Below chance performance (.05) on one or more forced-choice measures.
2.2. High posterior probability (.95 that performance is substantially below actual ability level) on one or more well-validated psychometric indices.
2.3. Self-reported symptoms are unambiguously incompatible with or directly contradicted by directly observed behavior and/or test performance.
3. Possible indicators of exaggeration/fabrication of neuropsychological problems or deficits.
3.1. Data from one or more well-validated psychometric measures, although not sufficient to meet Criterion 2a or 2b, are on balance more consistent with noncompliance than compliance.
3.2. Marked and implausible discrepancy between test performance and level of function expected based on developmental and medical history.
3.3. Marked and implausible discrepancy between test performance and directly observed behavior and capabilities.
3.4. Marked and implausible discrepancy between test performance and reliable collateral reports concerning behavior and capabilities.
3.5. Marked and implausible discrepancy between self-reported and documented history, consistent with exaggeration of preinjury level of function and capabilities, minimization or pre-existing injuries or neuropsychological problems, and/or exaggeration of the severity of new injuries.
3.6. Marked and implausible discrepancy between self-reported symptoms and level of function expected based on developmental and medical history.
3.7. Marked and implausible discrepancy between self-reported symptoms and information obtained from reliable collateral informants.

The authors also recommended that diagnoses and constructs may need to be considered in cases of evidence of Neuropsychological Dysfunction symptoms of exaggeration or fabrication. Among them: Conversion disorder, Dissociative amnesia, Factitious disorder, Adjustment problem/disorder with specious symptoms, Cogniform condition/disorder, Neurocognitive hypochondriasis, Stereotype threat, and Oppositional-defiant presentations.

To sum up, as pointed out by Zago and colleagues[37], the updated criteria have better specified the role that psychiatric, neurological, or developmental factors play by introducing the concept of 'simulation secondary to [...]' to be applied on a case-by-case basis. More attention is also paid to the subject's self-report. Moreover, a list of differential diagnoses and categories has been generated to enable the expert to better understand the different origins of potential symptom production/exaggeration. This

is so that attention is paid not only to cognitive dysfunction, but also to psychogenic and mixed organic/psychogenic dysfunction.

Psychophysiological lie detection techniques

According to some research[38] those who lie tend to appear more nervous, more agitated than those who tell the truth. This attitude is due both to:

1. the fear of being discovered, which has also been described as responsible for cues to deception[39], producing higher physiological activation;
2. the substantial cognitive effort that would require a lie, so much so that initially, the research aimed to discover techniques to identify the lie focused precisely on observing verbal and non-verbal behavior that accompanied the deceptive statements.

However, over time it was concluded that this correlation between lying and observable behavior was not strong enough to be used as objective evidence of a lying act. For this reason, research has focused on detecting and monitoring psychophysiological variables. Suppose the typical emotions of these situations such as anxiety, tension, fear of being discovered are physically translated with the intensity of the activation of behavioral indices. In that case, measuring and monitoring these indices could have been the trace left by the lie and constitute the evidence for the correct lie detection.
In 1914 Vittorio Benussi[40] created the first version of the polygraph, an emotion-based lie detection technology designed to detect and record simultaneously different physiological variations such as blood pressure, heart rate, and breathing patterns, in concurrence with the task performed by the subject. This instrument's great advantage lies precisely in the possibility of measuring the reference indices while the participant is conducting a test. To date, it is widely used to record the physiological responses of a person undergoing interrogation. Still, although it is the instrument par excellence for carrying out these analyses, it has many limitations. According to Saxe[41], the polygraph can undoubtedly measure a physiological activation pattern but can't be considered directly related to the production of a lie. It is thought that the psychophysiological activation, the arousal, which would trigger reactions such as increased heart rate, cannot be directly linked to the act of lying. A subject exposed to a "lie detector" could be revealed an increase in heart rate merely because he is subjected to a polygraph or for other reasons that cannot be (with certainty) related to lying.
Additionally, we must remember that not all individuals are aroused when they produce deceptive responses[42]. The polygraph and other lie detectors based on physiological activation do not measure a direct correlation of lying but rather estimate a pattern of physiological activation produced by any event that can be defined as stressful. The polygraph, not coincidentally, has a problematic generalisability due to

various subjective characteristics that dirty the data and make them not wholly reliable. The polygraph leads to a high risk of false positives, categorizing honest people as liars and few false negatives[43]. Given the limited scientific evidence in favor of the accuracy of the polygraph, and for an ethical issue related to invasion of privacy, its use has been considerably restricted, so much so that in some countries, it has been prohibited by law because it is considered a violation of individual freedom[44].

Starting in the 1980s with the use of event-related potentials (ERPs) up to recent years with functional magnetic resonance imaging (fMRI), the research of new technologies in all fields of research and, in this case, in neuroscience, has allowed the development of increasingly sophisticated techniques for cognitive and neural exploration associated with the generation of deceptive[45]. These are still physiological measures, but they analyze specific brain components. ERPs are event-related brain potentials measured using electrodes placed on the scalp that record electrical brain activity in response to physical stimuli, associated with psychological processes, and preparation for motor activity. These are, in simple terms, alterations that recur within the spontaneous EEG in the presence of an event internal or external to the individual, i.e., a brain response in close temporal relation to a stimulus or event[46].

The rationale of ERP techniques is that recognition of infrequent and well-known events (e.g., crime scene details) modulates brain potentials such as the P300 or that the response conflict (e.g., the inhibition of an honest response while producing a faked one) modulates the amplitude of medial frontal negativities. This technique offers a considerable advantage because it is hardly manipulable by the suspect and, therefore, undoubtedly more resistant than the polygraph, which is more easily subject to manipulation[47].

The second technique mentioned is fMRI, or functional magnetic resonance imaging, which allows visualization of the hemodynamic response in the brain as a function of the activity it is to perform. This technique is based on the fact that in the active areas of the brain, there is an increase in blood flow[48], so it has often been used to detect which areas were activated, based on the supply of blood and therefore oxygen in those particular areas. The aim is to obtain measurements of cerebral blood flow in individuals engaged in deception. Many researchers interested in lie detection have used this technique to search for brain areas active during the production of a lie. During an experiment conducted by Fullman[49], participants during the execution of a task in which they were asked to lie were subjected to fMRI, and the results showed an activation of the ventromedial prefrontal cortex, while in the subjects included in the control group this activation was not recorded.

This is still a preliminary phase. Although it is undoubtedly attractive, many consider dangerous the use of these techniques in the legal field, given the risk that this could lead to imprudent use of the instrument, accepting as accurate results not yet fully validated.

Behavioral lie detection techniques

According to some authors[50], the simplest, most immediate, and perhaps more or less affordable way to detect lies would be behavioral observation and analysis from verbal and nonverbal perspectives.

One of the most experts on lying and nonverbal communication is undoubtedly Paul Ekman. According to Ekman, to detect lies, we should observe a person's non-verbal behavior lying instead of relying on his words. Words are easily controllable, and we wold be easily misled if we relied only on verbal communication. Rather, a person's behavior (e.g., movements or facial expressions) is much more challenging to manage and control. This difficulty happens because when we lie, our attention is focused on what we have to say. We focus on finding the right words to make the lie believable, but we neglect that lie can leave a trace on our faces or be expressed through our gestures. Ekman's studies on lying are based on the assumption that the behavioral manifestation of emotions, mainly through facial expressions, is not culturally learned but innate and universal. Around the 1970s, he followed an isolated tribe in New Guinea and identified six basic universal expressions: joy, sadness, fear, disgust, anger, and surprise. Later he added others, expanding his list, but based on these six began the first studies on lying, starting a project with Maureen O'Sullivan. He discovered the facial micro-expressions: micro-movements of facial muscles that appear from 1/2 to 1/25 of a second.

Soon after, with his colleague Wally Friesen in 1974, he created the Facial Action Coding System (FACS), which collected and classified all the human face's micro-expressions. Inside the FACS are contained all the information to decode the language of emotions by breaking them down into individual units (AU, Action Unit)[51]. According to the authors, it is challenging to hide a felt emotion, stopping it in the bud and thus preventing its direct manifestation on our face. Compared to truth-tellers, liars are more likely to betray their words through gestures or expressions. For example, it has been shown that deceivers show fewer micro-expressions and gestures than honest due to the more significant cognitive load that the lie involves. It is as if deception leads to neglect in gestures[52].

However, recognizing and correctly interpreting of facial expressions and lying is not easy to perform (bear in mind that micro-expressions appear for a few milliseconds on the face); it is challenging, even for a trained eye, to catch and recognize them. Bond and DePaulo[53] analyzed the accuracy of some subjects in recognizing truths and lies. Their collected results found that only 54% of their responses correctly identified 47% as lies and 61% as non-deceptive responses.

Although this type of methodology is not entirely accurate, the assumption that lying involves a higher cognitive load is confirmed by numerous research studies that have developed various lie detection techniques based on this.

Cognitive lie detection techniques

Lying requires more cognitive resources than telling the truth[54]. This increase in cognitive demands can be seen even exteriorly: liars have significantly fewer eye movements[55], an increase in reaction times, pupil dilation, and fewer hand movements (such as illustrator gestures)[56], different levels of skin conductance (SCL), and distinct facial expressions pattern[57].

Two reliable and straightforward indexes of cognitive load associated with lying are reaction times (RTs) and error rate[58]. The hypothesis drives the assumption that a more demanding task would require a longer time to be carried out than an easier one. Therefore lying, being more taxing than telling the truth, would reveal itself with longer RTs and more errors. A meta-analysis on the relationship between reaction time and faking corroborated that honest respondents take less time to answer[59]. In other words, they take the time necessary to formulate the lie producing an increase in the number of errors and reaction time[60].

Several studies use response times within their paradigm. Mazza and colleagues (2019) utilized them in observing responses to MMPI-2; Monaro and colleagues also used them in association with unexpected questions[61]. Among the techniques that take advantage of these data, it is worth mentioning the Guilty Knowledge Test[62] and the Autobiographical-IAT[63].

The interesting point is that the more challenging the task, the longer the reaction times are. If, for example, we asked the participant to switch between a task that requires answering some questions lying and one in which they must be honest, the switch between tasks with opposite instructions produces a cost in terms of TR and errors. The traditional example is that of the Stroop effect: when asked to name the color of the ink in which a word is written. In this case, powerful interference is present when the word is the name of a color contrasting with the ink color (e.g., word "BLUE" written in red ink). This effect happens because the task of reading a word is much more practiced than that of naming its color[64].

In 1927 Jersild[65] published a study about the ability to shift attention between one task and another. Here, students had to work through a list of items either repeating or alternating between a series of tasks (adding, multiplying, form-naming, and so on). When the tasks were similar but opposite (for example, adding or subtracting three from a two-digit number), the reaction times suffered noticeably compared to the single repeating task. Instead, they remained unchanged or even improved when the tasks were reasonably different (subtracting and writing). Spector and Biederman later explained this peculiar effect[66]: when tasks have no overlap, the items themselves can cue the appropriate task to perform: three can be subtracted only from a number, while the second task involved words. But a significant effect appears when alternating requires keeping track of the previously performed operation (addition or subtrac-

tion). What is created is a cost in response times (the Switch cost), the slowing of RTs, and an increase in error rate immediately after switching between tasks. Using this effect in lie detection is very powerful. Therefore, interesting results have been shown. Debey et al.[67] for example, conducted an experiment in which they investigated the effects of the switch between questions in which they had to answer honestly and others lying relating to activities carried out in the laboratory (experiment 1) or autobiographical facts (experiment 2). The results showed an increase in reaction times and accuracy caused by the switch from lying to truth and vice versa, without differences between the two cases (from lies to truth or truth to lies).

Recent approaches in malingering detection

Most of the techniques mentioned above belong to the traditional lie detection approach and allow to detect simulation via analysis of generalized malingering behaviors rather than a specific one. Recent procedures include tools aimed at detecting specific malingered information: the aIAT[68] and TARA[69].

Autobiographical IAT

The autobiographical Implicit Association Test (aIAT)[70], developed as a variant of the famous Implicit Association Test (IAT)[71], is a technique that allows establishing the existence of a specific autobiographical memory trace within the respondent's mind/brain. This is a beneficial improvement since it allows evaluating which one of two autobiographical events is true.

The method consists of a computerized categorization task. That includes stimuli belonging to one of four categories. Two of these categories are logical categories, represented by sentences that are certainly true (e.g., "I am in front of a computer") or certainly false (e.g., "I am climbing a mountain") and relative to the precise moment of testing. The other two categories comprise alternative versions of the autobiographical event under investigation (e.g., "I went to Paris for Christmas" or "I went to London for Christmas") where only one of the two is true. The aIAT is organized in five classification blocks. In each trial, a stimulus was presented at the center of a computer monitor. Participants were requested to classify the stimulus as quickly and accurately as possible by pressing one of two labeled keys. Blocks 1, 2, and 4 are categorization blocks, while 3 and 5 are combined. In blocks 1, 2, and 4, each response button classifies sentences belonging to only one category. In contrast, in double blocks (3 and 5), each response button categorizes sentences into two different categories.

aIAT is based on the principle that pairing a truly autobiographical event with certainly true sentences should yield faster responses so that the specific pattern of RT's responses for the double categorization blocks indicates which autobiographical event is either true or false. The true autobiographical event is the one that generates faster

RTs when in the block where it shares the same motor response with true sentences. In other words, faster responses are facilitated when congruent sentences are paired together (e.g., a truthful autobiographical event with an undoubtedly true sentence). That being said, the comparison of interest was between average RT in Block 3 and average RT in Block 5.
This computerized task has been validated through experiments, starting from the laboratory to real-life situations, reaching, on average, a classification accuracy of 92%[72] However, this technique is not immune to limitations since the liar, if instructed, can falsify the measure by checking its response latency[73].

Timed Antagonistic Response Alethiometer

Another computer-based task is the Timed Antagonistic Response Alethiometern, also known as TARA[74]. The TARA is a timed multi-block classification that requires subjects to classify a succession of mixed statements as true or false as quickly and accurately as possible by pressing one of two keys. Specifically, it requires truth-tellers to complete two alternating compatible classification tasks, while liars must complete them using contradictory strategies. Incompatible classification is incrementally taxing to cognition than compatible one. Consequently, performances for dishonest respondents are expected to feature higher reaction times if accuracy stays the same. In short, longer average RTs indicate dishonesty while shorter ones suggest honesty. Experimental studies reached an accuracy rate of around 85% in detecting liars.

The implicit lie detection technique

All of the techniques mentioned above can be called "explicit" since the subject knows that he or she is being observed and what specific measurements are being collected. A new generation of instruments aims to measure these data while keeping the deceiver in the dark. These techniques can be called "implicit". Moreover, methods based on reaction times cannot provide a dynamic measure of the cognitive processing that the subject is performing. Consequently, researchers focused on tapping cognitive processing in real-time to address these limitations, which was practical and economical. Research has recently been developed, and a new technique based on the mouse's movement, hand-motor tracking, and keyboard dynamics has been introduced to detect deception.
Hibbeln and colleagues analyzed mouse movements in online insurance fraud[75]. The deception in their study was characterized by: increased normalized movement distance, decreased movement speed, increased reaction time, and more left clicks. In 2010 some authors compared motor trajectories while participants worked on a task that required them to lie and give a truthful response using a Nintendo Wii remote control[76]. Analysis of the trajectories of arm movements showed how faked responses

could be distinguished from true answers based on: motor start time, total reaction time, movement trajectory, and kinematic parameters for velocity and acceleration.
Monaro, Sartori, and Gamberini[77] also used this paradigm to detect faked identity using unexpected questions and mouse dynamics. In both experiments, the participants were randomly divided into two groups (liars and truth-tellers), and they had to respond to some questions about their real/fake identity. While truth-tellers respond automatically to unexpected questions, liars have to "build" and verify their responses. In both experiments, mouse movements were analyzed to detect liars. Results showed that RTs, mouse trajectories, and errors on unexpected questions efficiently distinguish liars from truth-tellers.
A second research conducted by Monaro and colleagues[78] reports a new method for identifying false self-declared identities based on mouse kinematic analysis as an implicit measure of deception while the user responds to personal information. The authors analyzed signatures of deception in terms of a) the shape of each movement trajectory, b) the position of the trajectory over time, c) speed, stability, and direction. Authors were able to detect the truth of self-declared identities with high accuracy of about 95%. Accordingly, kinematic analysis of the subject's response is a promising technique to use in forensics, both in cases where the truthfulness of the testimony needs to be evaluated and in insurance cases where forgeries are not easily detected.
Compared to other techniques (e.g., RT or psychophysiological technique), kinematic analysis of mouse movements has different advantages[79]:

1. It allows the cognitive complexity of stimulus processing to be captured by registering a variety of indicators, not just reaction time.
2. It is an implicit lie detection technology.
3. A large number of motion features seems, in principle, difficult to control by efficient countermeasures for lie detection.
4. This method may achieve high accuracy for a particular symptom rather than for a range of symptoms that make up the spectrum of a specific pathology.
5. This technology is inexpensive and does not require additional equipment that the subject already uses during interaction with the computer.
6. These indices are also very suitable for detecting lies online.
7. Do not require any particular expertise for the examiner to be used as early as the screening stage.

Artificial intelligence in malingering detection

A new research strand in this field is characterized by increasing new computer science technologies to solve outstanding issues and improve current methods. One of

the most promising lines of research emerges from the close collaboration between neuroscience, computer science, and bioengineering. The ultimate aim will likely be to establish a computerized system capable of "labeling" patients with a specific diagnosis based on objective elements. Also, in detecting somatic and psychiatric damage, an algorithm would be ideal for identifying whether the patient's stated symptoms are simulated or real based on the objectivity collected[80]. Although we are far from fulfilling this scenario, there are already some techniques and methods that can be used in the forensic phase with excellent results. Currently, one of the most promising areas that fall within Artificial Intelligence (AI) is Machine Learning (ML)[81].

Machine learning is a branch of artificial intelligence that uses statistical methods to improve the performance of an algorithm in detecting a pattern in a data set. This method may use mathematical algorithms to categorize objects into different classes, make predictions about new data, or generate new knowledge based on actual observations (e.g., patient data). This process isolates and captures salient features characterized by objective indices of deception to analyze the relationships between observed variables and develop automatic classification rules for the data.

The difference between statistics and ML is highlighted by Breiman[82]. Here, he explained that the classical orthodox statistical approach assumes that a particular stochastic data model generates data and that evaluation tends to focus on the extent to which the data fit the model. Statistical inference based on modeling data has been the standard procedure for analyzing scientific experiments since 1940. On the contrary, ML treats the data mechanism as unknown and mainly focuses on predictive accuracy and model agnostic.

Statistics requires the choice of a model that can embody our knowledge of a particular system; this choice is justified by whether the researcher believes it satisfactorily captures the essence of the system. On the other hand, ML requires us to choose a predictive algorithm based on its empirical capabilities. This means that we select algorithms to learn patterns based on past performance in similar scenarios. Both provide a valuable method for arriving at biologically meaningful conclusions[83]. Orrù and colleagues (2020) claim that ML could be helpful in complementing known inferential statistics and achieve two essential goals:

a. the development of models that can generalize and replicate their results to new data. This insight would solve the doubt about the reliability of research findings in behavioral research[84]. With this suggestion, the authors argue that augmenting the analytic workflow of psychological experiments with machine learning-based analysis can maximize accuracy and minimize reproducibility problems.
b. The development of models that focus on prediction at the group level, especially at the individual subject level.

In recent years, ML has offered sophisticated analysis techniques that have proven helpful in identifying a liar, such as using kinematic analysis of motor response to a double-choice task[85].

The application of ML analyses to these behavioral indices has been successfully performed in several studies. Some groundbreaking studies have shown that liars can be automatically identified by applying machine learning techniques to the kinematic analysis of motor responses to dual-choice tasks[86]. Moreover, these have used keyboard dynamics for fake identities in the laboratory[87] and online[88], mouse tracking in depression[89], and fake identities[90]. When applied to psychiatric symptoms, which are more complex to detect than autobiographical memories and identity data, ML techniques provide algorithms that can discriminate between malingerers and honest raters with good results, for example, by taking into account both the score in response to administered psychological tests and kinematic indices of mouse movement recorded during the task[91].

Neuropsychological and psychological malingering

In the clinical setting, malingering (and techniques to detect it) has been distinguished as malingering of neuropsychological or psychological disorders.

The most common neurocognitive disorders are amnesia, dementia, deficits in cognitive and executive functions, and more. Psychologists rely mainly on the performance level obtained during the cognitive assessment to diagnose any neurocognitive impairment. In these cases, examinees might malinger their impairments by exaggerating or faking symptoms. However, there is no way to fake good since people cannot perform better than their current performance level. The only exception regards the "coaching", i.e. when the lawyer or the psychologist trains the examinee on how to respond correctly to the test to obtain a higher level of performance.

*Traditional Techniques to Detect Malingering in Psychological and Neuropsychological setting*The following are some methods and logic that the professional may draw to detect malingering:

1. *Anatomic-clinical correlation*: this procedure pretends to detect malingering, corroborating the results from neuropsychological tests with neuroimaging evidence. In these cases, discrepancies suggest the suspect of some malingered behavior. Differences may emerge in qualitative and quantitative aspects of the disease, such as the location of the lesion and gravity of symptoms.
2. *Floor effect strategy*: this strategy assumes that simulators tend to fake any test during the assessment. For that reason, psychologists hide elementary tasks in complex tasks. The peculiarity is that even a patient with severe

dementia will be able to complete the easy task; in fact, the mean score obtained by the validation sample is established as the maximum score. However, a simulator will try to fail the task so any mistake in these elementary tasks can be considered an attempted simulation. Many tests, such as the Rey 15 items test, the Rey Word Recognition Test, the Rey Dot Counting Test, the B Test, rely on this logic.

3. *Symptom Validity Testing*: this strategy was developed by Pankratz and consisted in a forced-choice test where answering by chance would grant a 50% accuracy[92]. The assumption is that genuine patients with a deficit in a specific cognitive function (e.g., memory) will perform a memory test by chance. A performance below chance is implausible; hence, apparently, the individual recognizes the correct answers but deliberately chooses not to select them to convey a fake bad profile. This strategy is employed in many tests such as Test of Memory Malingering (TOMM), Letter Memory Test, 48-Pictures Test, Digit Memory Test (DMT), Portland Digit Recognition Test (PDRT), Victoria Symptoms Validity Test (VSVT), Computerized Assessment of Response Bias (CARB), 21-Item Test, Coin In The Hand Test, and more.
4. *Violation of a scientific law*: if the examinee violates a scientific law during the examination, he is considered a malingerer (e.g., the evaluee cannot verbally repeat a span of 3 items on a short-term memory task but succeeds in repeating a span of 5 items).

When dealing with psychological/psychiatric disorders, we refer to all the diseases collected in the Diagnostic and Statistic Manual of Mental Disorder -5 (DSM-5). The main problems of a psychiatric diagnosis are a) the absence of neural alteration or any biomarkers, b) the diagnosis based on ambiguous criteria, c) the fact that diagnosis relies merely on self-reported symptoms. Taken together, faking or masking a psychiatric disorder should be very feasible. To spot faking (bad or good) when reporting psychiatric symptoms, different authors supply a short collection of the methods:

- *Incoherent psychopathology:* classical psychiatry and control scales of personality inventories rely on this principle. The logic is that the expert should compare the examinee's symptoms with the phenomenology of that mental disorder. If any discrepancies are revealed, it should be assessed as a possible index of simulation or dissimulation.
- *Scenarios method:* this method consists of administering a questionnaire with psychiatric symptoms set in a realistic context. Simulators tend to reply in a pathological way describing their symptoms as not only false but also severe.

- *Qualitative analysis of typical characteristics of malingering:* This analysis identifies some typical attributes of malingering[93]:
  - Simulators become increasingly normal as time goes by, so it could be helpful to lengthy schedule interviews to allow this feature to emerge if malingering is suspected.
  - Delusions and hallucinations are frequently artificially produced, but catatonic behavior and inappropriate effect are rarely simulated. Hence, ill-intentioned evaluees are more likely to draw attention to positive symptoms.
  - Aberrations in content rather than form of thought. A truly mentally ill person will tend to produce disorganized speech, loose associations, and flights of ideas that characterize thought disorder and are instead almost impossible to fake during a long interview.
  - Over-playing and reminding. Malingerers are more likely to call attention to their delusions.
  - The simulators tend to give approximate answers.
  - Positive answers are given in order to confirm symptoms. Usually, malingerers display this kind of behavior because of their belief that endorsing a symptom will increase the appearance of psychopathology.
  - High reporting of symptoms unrelated or inconsistent with any mental disorders to convey a more severe disorder with a larger number of reported symptoms.
- *Discrepancy method:* the discrepancy method evaluates the syndromic associations of symptoms that do not correspond to known syndromic entities in the malingerer. This implies that the examiner makes a clinical evaluation of the difference between observed findings and typical findings expected in a claimed disease. Larrabee proposed five forms of discrepancy to be analyzed before one considering diagnosing genuine problems[94]:
  - Internal consistency of neurobehavioural domains: grossly divergent performance on tests that should be highly correlated.
  - Disease-deficit compatibility: reported or produced symptoms are not primary manifestations of the claimed disorder.
  - Inconsistency with the severity of injury: divergence between the magnitude of the disease and impairment with related symptoms.
  - Ecological discrepancy: inconsistency between scores on a specific domain in clinical tests and observed behaviour in the same domain.
  - Violation of performance curves. Test performance is affected by the difficulty level of the task. If a set of items ranging from relatively easy to difficult is presented, honest responders should perform better on easy items

and poorly on difficult ones. Malingerers, instead, may perform well in relatively difficult items and worse in relatively easy ones.

- *Rare symptoms and unrelated symptoms*[95]. The evaluee may report rare symptoms infrequently seen in a clinical population or might be recognized as indiscriminately endorsing a wide variety of symptoms without a specific set of symptoms or a specific diagnosis in mind. Malingerers can often feign obvious symptoms indicative of mental illness rather than those considered less associated with psychopathology. Given that, an examinee should be suspected of malingering if a person exhibits unusual or improbable symptoms, characterized by an extremely bad or fantastic quality or by extreme or unusual severity. Indeed, usually, malingerers can't predict how severe the symptoms should be. Finally, an ill-intentioned evaluee may err in either interpreting a stereotypical role according to erroneous stereotypes (e.g., describing a schizophrenic condition as "having two personalities"[96] or report symptoms that are not consistent with his behavior.
- *Structured Interview of Reported Symptoms (SIRS)*[97]. This interview comprises 172 items designed to assess a wide range of psychopathology and symptomatology. It consists of eight primary scales and five supplementary scales, developed to identify 13 distinct response styles in the respondent. Scores from the primary scales are classified into one of the four categories: honest responding, indeterminate, probable feigning, and definite feigning. It is recognized as satisfactory in terms of reliability and validity and provides 97% accuracy in the classification of malingerers[98]. Its primary scales are: RS (Rare Symptoms) includes seemingly valid but really rare symptoms (similar to the F scale from MMPI-2), SC (Symptom Combinations) is similar to RS but referred to pairs of symptoms, IA (Improbable or Absurd Symptoms) is for intrinsically improbable and absurd symptoms, BL (Blatant Symptoms), SU (Subtle Symptoms), SEV (Severity of Symptoms), SEL (Selectivity of symptoms), RO (Reported vs. Observed Symptoms). The five supplemental scales include DA (Direct Appraisal of Honesty; asking explicitly to indicate their honesty during evaluation), DS (Defensive Symptoms; common symptoms that, if denied, are a sign of defensiveness), SO (Symptom Onset; atypical onset), OS (Overly Specified Symptoms), INC (Inconsistency of Symptoms; 32 repeated items).
- *Structured Inventory of Malingered Symptomatology (SIMS)*[99]. This self-administered questionnaire composed of 75 dichotomous true/false items was constructed to detect deceivers' psychiatric and cognitive symptoms. This test operates through recognition of bizarre experiences and highly atypical symptoms focusing on the following domains: low intelligence (LI), affective

disorders (AF), neurological impairment (N), psychosis (P), and amnestic disorders (AM). This test provides a total score for probable malingering of psychological disorders with a sensitivity of 97.06%[100]. A Systematic Review and Meta-Analysis (van Impelen et al., 2014)[101] based on 41 studies concluded that this instrument can differentiate well between instructed feigners and honest responders; generates heightened scores in groups that are known to have a raised prevalence of feigning; may overestimate faking in patients who have schizophrenia, intellectual disability, or psychogenic non-epileptic seizures; and is reasonably robust against coaching. Recent research by Orrù and colleagues supports the application of machine learning techniques to develop a short version of the SIMS, with the final aim to reduce length while maintaining adequate accuracy of discrimination[102].

- *Inventory of Problems-29, IOP-29*[103] is a short, paper and pencil, self-administered measure of feigned mental and cognitive disorders and is particularly helpful in discriminating bona fide from feigned psychiatric and cognitive complaints.
- *M-Test*[104] was developed to identify malingering of schizophrenic symptoms and assess the possibility of faking or exaggerating psychiatric symptoms.
- *Control scale:* these are distinguishable in a) specific psychometric tools, explicitly developed to detect deceitful response styles, b) methods for detecting simulation and dissimulation that are implemented in standard psychodiagnostic tests, c) personality inventories, which were developed in clinical settings rather than forensic ones[105]:
  - *Minnesota Multiphasic Personality Inventory (MMPI-2)*[106]. This test is the most widely used and researched multi-scale measure of psychopathology. It contains 567 dichotomous (T/F) items and provides information on the subject's personality and correspondence with specific nosografic categories through 10 clinical scales, 15 content scales, and supplemental scales. This tool is handy due to validity scales that permit the generation of hypotheses of dissimulation and simulation checking for the reliability of the profile. These scales are: F (frequency), Fb (Back F), Fp (F psychopathology), Ds-r2 (Dissimulation-Revised), Fbs (Fake Bad scale), K (Defensiveness), S (Superlative Self-Presentation), F-K index (Dissimulation Index), L (Lie), Variable Response Inconsistency (VRIN) which assesses answering similar or opposite question pairs inconsistently, True Response Inconsistency (TRIN) assessing answering questions all true or all false. Additionally, there is a method of analysis of evident and subtle items. The F-K index has been proven to provide an accurate classification of malingerers (with accuracy reaching 90%)[107].

- *Personality Assessment Inventory (PAI)* (Morey & Staff, 1991)[108] is a psychometrically sound multi-scale inventory useful in clinical and forensic contexts; handy to identify exaggerated psychopathological symptom reports is its Negative Impression Management scale (NIM).
- *Negative Impression Management scale of the* PAI (NIM)[109]; is used to identify the exaggeration of psychopathology and possible malingering.

• *Cognitive test:* Many tests for detecting malingered cognitive symptoms mainly focus on detecting feigned memory impairment (one of the most frequent malingered cognitive symptoms). Here we present those most frequently used in clinical and forensic practice as they address often feigned symptoms.

- *Test of Memory Malingering* (TOMM)[110]; is a forced-choice recognition test composed of three trials (the third is optional) of 50 items designed for adults to discriminate between true memory-impaired patients and malingerers. This tool is handy to detect exaggerated or malingered memory impairment. A cut-off score of 45 on Trial 2 (i.e., 90% correct responding) and Tombaugh's investigations[111] revealed an accurate classification of 95% of all non-demented patients as not malingering.*Rey's 15-Item Visual Memory Test* (MFIT)[112] is used to screen malingered memory impairment. It consists of 15 different symbols set up in a table of three rows and five columns. The respondent is shown the table for 10 seconds. Then he will be asked to draw everything he can remember. The traditional scoring method involves counting the total number of items correctly recalled, with scores of less than nine to raise the suspicion of malingering.
- *Word Memory Test* (WMT)[113] is a computer-administered memory task. The patient is presented a list of 20 items words. Then, words appear in pairs: the first word followed by the next (1 second later). The pair disappears, and another set is presented 2 seconds later. The list is shown twice, and the subject is asked to recall as many word pairs as possible.
- *Dot Counting Test* (DCT)[114] is another screening measure for malingering. It consists of 12 cards on which are printed a series of dots. Respondents are presented with the cards in a fixed non-sequential order and are instructed to count the number of dots as quickly as possible. For honest patients, it is expected that the time for measuring proportionally increases when dots are ungrouped rather than when they are grouped.

All the instruments presented previously are tests for which validation studies have been published, satisfying the Daubert criteria considered in evaluating the admissibility of these instruments in Court as scientific evidence: (1) empirical testing (the

theory or technique in question must be testable, falsifiable and refutable); (2) subjected to peer review and publication; (3) known or potential error rate; (4) the existence and maintenance of standards and controls concerning its operation; and (5) degree to which a relevant community generally accepts the theory and technique.

Conclusion

In medico-legal practice and assessing an examinee's mental state, detecting deception is one of the most critical and challenging issues. Malingering can be defined as an intentional production of faked or exaggerated physical, psychological or neuropsychological symptoms, including psychopathology disorder, intellectual or neuropsychological impairment (cognitive impairment), or medical syndrome.
When trying to spot deception, two important key features must be considered:

a. the intentionality of the subject in the production of symptoms;
b. the presence of external incentives associated with the behavior (e.g., economic/societal/legal gain).

Since psychiatric and cognitive symptoms can be easily exaggerated/feigned and the incidence of malingering in a medico-legal setting (25-45% of faking attitudes), detecting deceptive efforts has become a priority in the forensic field.
Appropriate strategies, methods, and lie detection techniques have changed over time, passing from polygraph to computerize procedures to machine learning algorithms and increasing the accuracy level of deception.
Despite that, none of them can be considered without limitations and criticism-free, but combining their use with new developing automatized methods can increase the accuracy of the examiner's ability to detect malingering.

Bibliography and notes

1. Ganis G, Keenan JP, The cognitive neuroscience of deception. Social Neuroscience 2009;4(6):465-472.
2. Ganis G, Keenan JP, Cf. note 1.
3. Evans AD, Xu F, Lee K, When all signs point to you: lies told in the face of evidence. Developmental Psychology 2011;47(1):39.
4. Anolli L, Mentire. Bologna: Il Mulino; 2003.
5. DePaulo BM, Kashy DA, Kirkendol SE, Wyer MM, Epstein JA, Lying in everyday life. Journal of Personality and Social Psychology 1996;70(5):979.
6. Abe N, The neurobiology of deception: Evidence from neuroimaging and loss-of-function studies. Current Opinion in Neurology 2009;22(6):594-600. https://doi.org/10.1097/WCO.0b013e328332c3cf
7. Anolli L, Cf. note 4.

8. Anolli L, Cf. note 4. Ellingson JE, McFarland LA, Understanding faking behavior through the lens of motivation: An application of VIE theory. Human Performance 2011;24(4):322-337.
9. Kühn CG, Claudi Galeni opera omnia. Lipsiae: Officina libraria car. CnoblochiI; 1830. XIX.
10. Zago S, Sartori G, Scarlat G, Malingering and retrograde amnesia: The historic case of the Collegno amnesic. Cortex 2004;40(3):519-532.
11. Lezak MD, Howieson DB, Loring DW, Fischer JS, Neuropsychological assessment. Oxford: Oxford University Press; 2004.
12. Stracciari A, Bianchi A, Sartori G, Neuropsicologia forense. Bologna: Il Mulino; 2010.
13. Mittenberg W, Patton C, Canyock EM, Condit DC, Base rates of malingering and symptom exeggeration. Journal of Clinical and Experimental Neuropsychology 2002;24(8):1094-1102.
14. Stracciari A, Bianchi A, Sartori G, Cf. note 12.
15. American Psychiatric Association A. P. A., & A. P. A. Diagnostic and statistical manual of mental disorders: DSM-5 (5th ed.). 2013.
16. Braun HI, Jackson DN, Wiley DE, Socially Desirable Responding: The Evolution of a Construct. In: The Role of Constructs in Psychological and Educational Measurement. London: Routledge; 2001. pp. 49-69. https://doi.org/10.4324/9781410607454-10. Crowne DP, Crowne DP, Marlowe D, The approval motive: Studies in evaluative dependence. New York: Wiley; 1964.
17. Stracciari A, Bianchi A, Sartori G, Cf. note 12.
18. Hurst AF, Treatment of War Hysteria. British Medical Journal 1940;1(4141):828.
19. Stracciari A, Bianchi A, Sartori G, Cf. note 12.
20. Bass C, Halligan P, Factitious disorders and malingering: challenges for clinical assessment and management. The Lancet 2014;383(9926):1422-1432.
21. Bass C, Halligan P, Cf. note 20.
22. Hall RCW, Hall RCW, Compensation neurosis: a too quickly forgotten concept? Journal of the American Academy of Psychiatry and the Law Online 2012;40(3):390-398.
23. Stracciari A, Bianchi A, Sartori G, Cf. note 12.
24. Sartori G, Orrù G, Zangrossi A, Detection of malingering in personal injury and damage ascertainment. In: Personal injury and damage ascertainment under civil law. Berlin: Springer; 2016. pp. 547-558.
25. Aamodt MG, Custer H, Who can best catch a liar? Forensic Examiner 2006;15(1):6. Drob SL, Meehan KB, Waxman SE, Clinical and conceptual problems in the attribution of malingering in forensic evaluations. Journal of the American Academy of Psychiatry and the Law 2009;37(1):98-106.
26. Bond Jr CF, DePaulo BM, Accuracy of deception judgments. Personality and Social Psychology Review 2006;10(3):214-234.
27. Bond Jr CF, DePaulo BM, Cf. note 26.
28. Roncoroni L, Contributo allo studio della simulazione. Archivio Di Psichiatria 1987;IV.
29. Zago S, Difonzo T, La simulazione di stati patologici mentali: aspetti generali e nel contesto penitenziario. Dipendenze patologiche in area penale. Interventi multidisciplinari di cura e contesti legislativi. Materia Medica; Milano: 2018.
30. Ingegnieros J, La Simulazione Della Pazzia in Rapporto Alla Criminologia: La Medicina Legale E La Clinica Psichiatrica. Torino: Fratelli Bocca Editori; 1904.

31. Lombroso C, Leggiardi-Laura C, La perizia psichiatrico-legale: coi metodi per eseguirla e la casuistica penale classificata antropologicamente (con 4 tav. e 48 fig. interc. nel testo). Torino: Fratelli Bocca Editori; 1905.
32. Zago S, Difonzo T, Cf. note 29.
33. Zago S, Sartori G, Scarlat G, Cf. note 10.
34. Slick DJ, Sherman EMS, Iverson GL, Diagnostic criteria for malingered neurocognitive dysfunction: Proposed standards for clinical practice and research. The Clinical Neuropsychologist 1999;13(4):545-561.
35. Boone KB, A reconsideration of the criteria for malingered neurocognitive dysfunction. Assessment of Feigned Cognitive Impairment: A Neuropsychological Perspective 2007;29-49. Zago S, Bolognini N, Mega A, DifonzoT, Sartori G, L'identificazione della simulazione di disfunzioni cognitive: un confronto tra i vecchi e i nuovi criteri di Slick e colleghi. Rivista Italiana Di Medicina Legale 2018;40:481-497.
36. Slick DJ, Sherman EMS, Differential diagnosis of malingering and related clinical presentations. Pediatric Forensic Neuropsychology 2012;113-135. Slick DJ, Sherman EMS, Differential diagnosis of malingering. Mild Traumatic Brain Injury: Symptom Validity Assessment and Malingering, 2013. pp. 57-72.
37. Zago S, Bolognini N, Mega A, Difonzo T, Sartori G, L'identificazione della simulazione di disfunzioni cognitive: un confronto tra i vecchi e i nuovi criteri di Slick e colleghi. Rivista Italiana Di Medicina Legale 2018;40:481-497.
38. DePaulo BM, Lindsay JJ, Malone BE, Muhlenbruck L, Charlton K, Cooper H, Cues to deception. Psychological Bulletin 2003;129(1):74.
39. Ekman P, Friesen WV, Simons RC, Is the startle reaction an emotion? Journal of Personality and Social Psychology 1985;49(5):1416.
40. Benussi V, Antonelli M, (). Die atmungssymptome der lüge. Psychologische Schriften 2002;1:365-394.
41. Saxe L, Science and the CQT polygraph. Integrative Physiological and Behavioral Science1991; 26(3):223-231.
42. Ganis G, Keenan JP, Cf. note 1.
43. Brett A, Phillips M, Beary J, Predictive power of the polygraph: can the" lie detector" really detect liars? The Lancet, 1986;327(8480):544-547.
44. Stracciari A, Bianchi A, Sartori G, Cf. note 12.
45. Davatzikos C, Ruparel K, Fan Y, Shen DG, Acharyya M, Loughead JW, Gur RC, Langleben DD, Classifying spatial patterns of brain activity with machine learning methods: application to lie detection. Neuroimage 2005;28(3):663-668. Meixner JB, Rosenfeld JP, A mock terrorism application of the P300-based concealed information test. Psychophysiology 2011;48(2):149-154.
46. Pennisi P e Sarlo M, Indici Elettrofisiologici in Psicologia. Padova: Cleup Editrice;1998.
47. Rosenfeld JP, Bessinger GT, Feedback-evoked P300 responses in lie detection. Psychophysiology 1990;27:S60.
48. Ladavas E, Berti A, Neuropsicologia. Bologna: Il Mulino; 2002.
49. Fullam RS, McKie S, Dolan MC, Psychopathic traits and deception: functional magnetic resonance imaging study. The British Journal of Psychiatry 2009;194(3):229-235.
50. Ganis G, Keenan JP, Cf. note 1.
51. Ekman P, Friesen WV, Facial action coding system. Environmental Psychology & Nonverbal Behavior 1978.
52. Ekman P, Friesen WV, Hand movements. Journal of Communication 1972;22(4):353-374.

53. Bond Jr CF, DePaulo B M, Cf. note 26.
54. Vrij A, Fisher R, Mann S, Leal S, Detecting deception by manipulating cognitive load. Trends in Cognitive Sciences 2006;10:141-142. Christ SE, Van Essen DC, Watson JM, Brubaker LE, McDermott KB, The contributions of prefrontal cortex and executive control to deception: evidence from activation likelihood estimate meta-analyses. Cerebral Cortex, 2009;19(7):1557-1566.
55. Walczyk JJ, Griffith DA, Yates R, Visconte SR, Simoneaux B, Harris LL, Lie detection by inducing cognitive load: Eye movements and other cues to the false answers of "witnesses" to crimes. Criminal Justice and Behavior 2012;39(7):887-909.
56. Zuckerman M, DePaulo BM, Rosenthal R, Verbal and nonverbal communication of deception. Advances in experimental social psychology 1981;14:1-59.
57. Pennebaker JW, Chew CH, Behavioral inhibition and electrodermal activity during deception. Journal of Personality and Social Psychology 1985;49(5):1427.
58. Verschuere B, Spruyt A, Meijer EH, Otgaar H, The ease of lying. Consciousness and Cognition 2011;20(3):908-911.
59. Maricuțoiu LP, Sârbescu P, The relationship between faking and response latencies: a meta analysis. European Journal of Psychological Assessment 2019;35(1):3-13.
60. Walczyk JJ, Roper KS, Seemann E, Humphrey AM, Cognitive mechanisms underlying lying to questions: Response time as a cue to deception. Applied Cognitive Psychology: The Official Journal of the Society for Applied Research in Memory and Cognition 2003;17(7):755-774.
61. Monaro M, Zampieri I, Sartori G, Pietrini P, Orrù G, The detection of faked identity using unexpected questions and choice reaction times. Psychological Research 2021;85(6):2474-2482.
62. Lykken DT, The GSR in the detection of guilt. Journal of Applied Psychology 1959;43(6):385.
63. Sartori G, Agosta S, Zogmaister C, Ferrara SD, Castiello U, How to accurately detect autobiographical events. Psychological Science 2008;19(8):772-780.
64. MacLeod CM, Half a century of research on the Stroop effect: an integrative review. Psychological Bulletin 1991;109(2):163.
65. Jersild AT, Mental set and shift. Archives of Psychology 1927;89:1-81
66. Spector A, Biederman I, Mental set and mental shift revisited. The American Journal of Psychology 1976;89(4):669-679.
67. Debey E, Liefooghe B, De Houwer J, Verschuere B, Lie, truth, lie: The role of task switching in a deception context. Psychological Research 2015;79(3):478-488.
68. Sartori G, Agosta S, Zogmaister C, Ferrara SD, Castiello U, Cf. note 62.
69. Gregg AP, When vying reveals lying: The timed antagonistic response alethiometer. Applied Cognitive Psychology: The Official Journal of the Society for Applied Research in Memory and Cognition 2007;21(5):621-647.
70. Sartori G, Agosta S, Zogmaister C, Ferrara SD, Castiello U, Cf. note 62.
71. Greenwald AG, McGhee DE, Schwartz JL, (n.d.) K, Measuring individual differences in impl~ c~ t cognition: The implicit association test. Journal of Personality and Social Psychology 1998;74(6):1464-80.
72. Stracciari A, Bianchi A, Sartori G, Cf. note 12.
73. Sartori G, Zangrossi A, Orrù G, Monaro M, Detection of malingering in psychic damage ascertainment. P5 medicine and justice 2017;330-341.
74. Gregg AP, Cf. note 68.

75. Hibbeln M, Jenkins JL, Schneider C, Valacich JS, Weinmann M, Investigating the effect of insurance fraud on mouse usage in human-computer interactions. 35th International Conference on Information Systems: Building a Better World Through Information Systems, ICIS 2014.
76. Duran ND, Dale R, McNamara DS, The action dynamics of overcoming the truth. Psychonomic Bulletin & Review 2010;17(4):486-491.
77. Monaro M, Gamberini L, Sartori G, The detection of faked identity using unexpected questions and mouse dynamics. PLoS One 2017; 12(5).
78. Monaro M, Gamberini L, Sartori G, Identity verification using a kinematic memory detection technique. Advances in Neuroergonomics and Cognitive Engineering 2017; 123-132
79. Sartori G, Zangrossi A, Orrù G, Monaro M, Cf. note71.
80. Sartori G, Zangrossi A, Orrù G, Monaro M, Cf. note71.
81. Mitchell TM, Machine Learning. McGraw-Hill Education. 1997 (1st ed.).
82. Breiman L, Cox D, Breiman L, Comment-statistical modeling: The two cultures. Statistical Science 2001;16(3):199-231.
83. Orrù G, Monaro M, Conversano C, Gemignani A, Sartori G, Machine learning in psychometrics and psychological research. Frontiers in Psychology 2020;10:2970.
84. Pashler H, Wagenmakers E, Editors' introduction to the special section on replicability in psychological science: A crisis of confidence? Perspectives on Psychological Science 2012;7(6):528–530.
85. Monaro M, Gamberini L, Sartori G, Cf. note 76.
86. Monaro M, Gamberini L, Sartori G, Cf. note 76.
87. Monaro M, Galante C, Spolaor R, Li QQ, Gamberini L, Conti M, Sartori G, Covert lie detection using keyboard dynamics. Scientific Reports 2018;8(1):1-10.
88. Monaro M, Businaro M, Spolaor R, Li QQ, Conti M, Gamberini L, Sartori G, The online identity detection via keyboard dynamics. Proceedings of the Future Technologies Conference 2018;nov:342-357.
89. Monaro M, Toncini A, Ferracuti S, Tessari G, Vaccaro MG, De Fazio P, Pigato G, Meneghel T, Scarpazza C, Sartori G, The detection of malingering: a new tool to identify made-up depression. Frontiers in Psychiatry 2018;9:249.
90. Monaro M, Fugazza FI, Gamberini L, Sartori G, How human-mouse interaction can accurately detect faked responses about identity. Symbiotic Interaction 2017;115.
91. Monaro M, Toncini A, Ferracuti S, Tessari G, Vaccaro MG, De Fazio P, Pigato G, Meneghel T, Scarpazza C, Sartori, G, Cf. note 87.
92. Pankratz L, A new technique for the assessment and modification of feigned memory deficit. Perceptual and Motor Skills 1983;57(2):367-372.
93. Conroy MA, Kwartner PP, The definition of malingering. Applied Psychology in Criminal Justice 2006;2(3):30-51.
94. Larrabee GJ, Cautions in the use of neuropsychological evaluation in legal settings. Neuropsychology 1990;4(4): 239.
95. Sartori G, Orrù G, Zangrossi A, Cf. note 24.
96. Conroy MA, Kwartner PP, Cf. note 91.
97. Rogers R, Bagby RM, Dickens SE, Structured Manual. Interview of reported symptoms (SIRS) and professional. Odessa, FL: Psychological Assessment Resources, 1992.
98. Rogers R, Structured interviews and dissimulation. Clinical assessment of malingering and deception 2008;3:301-322.

99. Smith GP, Burger Gk, Detection of Malingering: Validation of the Structured Inventory of Malingered Symptomatology (SIMS). Journal of the American Academy of Psychiatry and the Law 1997;25(2):183-189.
100. Smith GP, Burger GK, Cf. note 97.
101. Orrù G, Mazza C, Monaro M, Ferracuti S, Sartori G, Roma P, The development of a short version of the SIMS using machine learning to detect feigning in forensic assessment. Psychological Injury and Law 2021;14(1): 46.
102. Viglione DJ, Giromini L, Landis P, The development of the Inventory of Problems. A brief self-administered measure for discriminating bona fide from feigned psychiatric and cognitive complaints. Journal of Personality Assessment 2017;99(5):534-544.
103. van Impelen A, Merckelbach H, Jelicic M, Merten T, The Structured Inventory of Malingered Symptomatology (SIMS): A systematic review and meta-analysis. The Clinical Neuropsychologist 2014;28(8):1336-1365.
104. Beaber RJ, Marston A, Michelli J, Mills MJ, A brief test for measuring malingering in schizophrenic individuals. The American Journal of Psychiatry.1985;142(12):1478-1481.
105. Stracciari A, Bianchi A, Sartori G, Cf note 12.
106. Butcher JN, Dahlstrom WG, Graham JR, Tallagen AKB (eds), MMPI-2: manual for administration and scoring. Minnesota:University of Minnesota Press; 1989.
107. Stracciari A, Bianchi A, Sartori G, Cf note 12.
108. Morey LC, Staff P, Personality Assessment Inventory Professional Manual. Odessa: Psychological Assessment Resources; 1991.
109. Morey LC, Staff P, Cf. note 97.
110. Tombaugh TN, Test of Memory Malingering (TOMM). Multi-Health Systems. New York: Springer; 1996.
111. Rees LM, Tombaugh TN, Gansler DA, Moczynski NP, Five validation experiments of the Test of Memory Malingering (TOMM). Psychological Assessment 1998;10(1):10. Tombaugh TN, Cf. note 107. Tombaugh TN, The Test of Memory Malingering (TOMM): Normative data from cognitively intact and cognitively impaired individuals. Psychological Assessment 1997;9(3):260.
112. Rey A, L'examen clinique en psychologie. Paris: Presses Universitaires de France; 1964.
113. Green P, Allen LM, Astner K, The Word Memory Test: A user's guide to the oral and computer-administered forms. US Version 1.1. Durham: NC: CogniSyst; 1996.
114. Lezak MD, Howieson DB, Loring DW, Fischer JS, Cf. note 11.