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True lies: delusions and lie-detection technology

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Abstract

Legally relevant lying is an intentional attempt to convince another of the truth of a proposition the liar believes to be false. Delusion is an unintentional product of impaired reality testing that occurs in a range of psychiatric conditions and psychological states, some of which could be clinically subtle, since deception, truth and delusion differ in the intent rather than reality testing criterion. Deception and delusion are influenced by the degree of congruence between subjective and objective reality and are probably mutually exclusive. Thus, a delusion could lead to an objectively false statement, that could nevertheless be subjectively true and indistinguishable from truth by its psychophysiological (i.e., the polygraph) signature. This article presents a relevant case as a starting point of an examination of the current and future role of neurophysiological (i.e., functional brain imaging) measurements in the detection of deception. The authors incorporate the recent data on functional brain imaging to the neuroanatomical mechanisms of true and false recall, behavioral regulation and deception into a testable model that could redefine deception and separate it from delusions on the basis of objective functional brain imaging measures.

Keywords

deception, lie, delusion, polygraph, fMRI, psychophysiology, psychosis, erotomania, defense mechanism, memory

Comments

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Legally relevant lying is an intentional attempt to convince another of the truth of a proposition the liar believes to be false. Delusion is an unintentional product of impaired reality testing that occurs in a range of psychiatric conditions and psychological states, some of which could be clinically subtle. Since deception, truth and delusion differ in the intent rather than reality testing criterion. Deception and delusion are influenced by the degree of congruence between subjective and objective reality and are probably mutually exclusive. Thus, a delusion could lead to an objectively false statement, that could nevertheless be subjectively true and indistinguishable from truth by its psychophysiological (i.e., the polygraph) signature. This article presents a relevant case as a starting point of an examination of the current and future role of neurophysiological (i.e., functional brain imaging) measurements in the detection of deception. The authors incorporate the recent data on functional brain imaging to the neuroanatomical mechanisms of true and false recall, behavioral regulation and deception into a testable model that could redefine deception and

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Case vignette

Dr. B is an experienced board-certified psychiatrist specializing in psycho- and pharmacotherapy of mood and anxiety disorders in young adults. Ms. A is her former patient, a single young woman, whom Dr. B treated since her late teens. Ms. A suffered from anxiety and depression and was treated with a combination of Venlafaxine, low-dose Olanzapine and insight-oriented psychotherapy. Ms. A also experienced dissociative symptoms, which Dr. B suspected to have been related to past sexual abuse, which Ms. A never explicitly endorsed and/or a personality disorder. After almost seven years of treatment, Ms. A dropped out of treatment without explanation. Dr. B only followed up with one letter to the patient, which went unanswered. Two years later, Ms. A sued Dr. B and her malpractice insurance company for damages for alleged sexual abuse during her treatment. She also threatened to file a complaint with the police and the state medical board if the case was not quickly settled. The suit alleged that while Ms. A was under the influence of psychoactive medication prescribed by Dr. B, the Dr. repeatedly fondled Ms. A's breasts and performed oral sex on her. Dr. B. vehemently denied the charges. When Dr. B reviewed Ms. A's treatment notes, she noticed a pattern of abnormal same-sex attachment to older females that she did not address in therapy at the time. Unusually, in a jurisdiction where polygraph evidence is not admissible in a court of law, both plaintiffs and defendant attorneys requested a polygraph examination of their clients, and both concurred. The results of the examination were negative in both cases, suggesting that both the doctor and the patient were "telling the truth." The suit was settled out of court for an undisclosed amount. This case highlights a number of issues at the interface of psychiatry, psychophysiological lie-detection, and the law.

First, transference exhibited by Ms. A in therapy combined with probable borderline or histrionic personality traits (dissociation) may have predisposed the patient to a delusional interpretation of her therapeutic relationship.[1] While there are multiple psychiatric restrictions on the capacity to stand trial, there are none on the capacity to sue (US Code Title 28, Rule 17). Delusions occur not only in psychotic patients who are unlikely to have much credibility in court, but also in patients with mood and personality disorders and individuals with otherwise intact reality testing who would appear credible in court or during a forensic evaluation. Thus, the limited need for probable cause and an unrestricted capacity to sue, make a civil malpractice lawsuit by a delusional patient a significant risk to a mental health practitioner.

Second, despite criticism by such authorities as the National Academy of Sciences and the United States Office of Technology Assessment, polygraph examination remains the unofficial gold standard of truth verification and even when inadmissible as evidence, could indirectly affect the course of litigation.[2,3] Had the parties in our vignette not submitted to a polygraph examination, they might not have settled out of court.

Third, the impact of discrepancy between objective and subjective reality caused by impaired reality testing, on the biological parameters (polygraph or otherwise) of responding during any interview seeking objective truth, has not been well studied. In fact, the confusion between the concept of subjective and objective reality is not uncommon not only among clients and patients but also the practitioners and researchers. In the case of Ms. A and Dr. B, the plaintiff's story is likely to be both subjectively true and objectively false; Ms. A believed that she has been molested by Dr. B and was thus not lying, however, the odds of such event having taken place are less than the those of Ms. A having had a delusion. Remarkably, our case does not serve as evidence against the polygraph examination, as it may initially appear: Both parties were telling their SUBJECTIVE truths and passed the polygraph examination.

Lack of data on the neurophysiology of deception and delusions, has been a major obstacle on the path to a reliable and reproducible lie-detection, in particular in individuals with abnormal reality testing. The goal of the present article is to re-examine these issues in light of recent advances in neuroscience research and to propose further direction for the study of those phenomena of particular relevance to forensic psychiatry. The proposal is based on a record of brain activity, which serves as a more solid material foundation than in previous studies.

Recently, significant progress has been made in three relevant areas: The functional and anatomical brain correlates of true and false recall,[4-6] the patterns of brain activity in patients with disorders of reality testing, such as schizophrenia[7-10] and the development of alternative methods of lie-detection, using correlates of central nervous system activity such as Electroencephalogram (EEG) and functional Magnetic Resonance Imaging (fMRI).[11-17]

Delusions

Delusions are a firmly held "false" belief that is inconsistent with the cultural beliefs of the subject's group. Even though implausibility and idiosyncrasy are both indices of a delusion, it is the incorrigibility—by logic or evidence—with which a conviction is held that serves as the hallmark of a delusion. From the viewpoint of lie detection, a firm conviction makes a statement subjectively true. According to Jaspers, "experiences that accompany delusions are often perceived as being real"[18, 19] yet, this conviction may be less stable than previously thought.[20] In fact, the degree of conviction in the veracity of a delusion is inversely related to the general severity of patients' psychotic state; frequently, this conviction is the target of pharmacotherapy and a gauge of treatment progress.[21] In clinical parlance this is referred to as "insight." Delusions may also serve as unconscious defenses against the anxiety caused by awareness of one's psychotic symptoms by rationalizing, organizing or "explaining" the hallucinations and paranoia, though this hypothesis has been recently challenged.[22] This internally beneficial role may account in part for the imperviousness of delusions to logical reasoning.

Though commonly associated with schizophrenia or acute mania, delusions are a symptom present in other psychiatric and neurodegenerative disorders as well. A disorder whose only manifestation is a delusion of romantic love by another person (erotomania) has also been described, often in the setting of a personality disorder: Patients with De Clerambault (delusion passionelle) syndrome have sued their doctors for malpractice in situations similar to the aforementioned case vignette.[23] A related disorder of pseudologia fantastica (Munchausen's syndrome) involves "pathological" lying, defined as lying for the "primary" or "internal", rather than "secondary" gain.[24] The term has also been misapplied to individuals with personality disorders lying for a secondary gain, where the pathology is not in the motive or goal of a deception but in the frequency with which they resort to it.[25] In psychotic disorders, delusions are indicators of psychotic loss of contact with reality.[26-28] A legal lie implies intent; thus, affirming one's delusion is not a lie, since subjectively it is a truth. In the legal setting, delusions pose a particular challenge for deception detection devices because they are expected to identify a deviation from objective truth with a device sensitive only to the correlates of subjects' internal (subjective) state. In the case of a delusional plaintiff or defendant this may be problematic, as in our vignette.

Deception

In contrast to delusion, deception has traditionally been defined as a conscious event or process. The basic components of a legally-relevant deception are intent, presence of a target and a conscious awareness of a reality incongruous with the one the liar is attempting to impart to the target.[29, 30] Remarkably and somewhat counter-intuitively, *the external (objective) veracity of an internal belief is irrelevant.*[31] Moreover, fabrication of a false story to replace the subjectively true one, while common, is not necessary: "Denying what is or confirming what is not" is sufficient to meet criteria for deception.[32] In the case of delusions, the internal belief is incongruous with external reality; however, the intent and awareness are absent. In summary, for the purpose of this article, lying or deception are defined as "a deliberate attempt to convince another of the truth of a proposition the liar believes to be false."

The polygraph

Despite controversial validity, inadmissibility as legal evidence and the ban on its use in non-government pre-employment screening, polygraph and its variants remain the only common psychophysiological methods of lie detection. Though frequently equated with the multichannel physiological recording (MPR) system it relies on, the polygraph is, strictly speaking, a combination of the MPR with a particular method of questioning, known as the Control Question Test (CQT). The CQT, in neuroscience terms, is an example of a "symptom provocation paradigm," namely, a structured task designed to provoke the symptom of interest at predetermined time(s). The structure of such deception "model" or "paradigm" usually reflects assumptions of the model designer, which may not always be obvious to or shared with the later users of the model or its results. For example, one of the assumptions in the CQT is that everyone has stolen something sometime in the past and that when asked to respond in the negative to a question: "Have you ever stolen anything," subjects will produce a neurophysiological response typical for a lie. This response is termed "presumed lie" and used for comparison with responses to questions, the true answers to which are unknown. An alternative deception paradigm is called the Guilty Knowledge Test (GKT). "Guilty" refers to prior knowledge, rather than the presence or absence of guilt. This paradigm is based on the assumption that, an enhanced psychophysiological response to a question about a specific detail of a particular crime (e.g., color of a stolen car) indicates possession of "Guilty Knowledge" and thus involvement in the crime in question.[33] Strictly speaking, a GKT combined with MPR is not a "polygraph." Though the debate about the advantages of each of the paradigms (CQT vs. GKT) for lie-detection has raged for decades, in neuropsychological terms both are "forced choice" paradigms.[34, 35] Both carry a number of flaws and potential confounds and are probably below the standards of paradigm design in modern experimental neuroscience. Yet, these deficiencies of the traditional lie-detection paradigms are not the "fatal flaw" that justifies the search for alternatives. The stronger argument against the polygraph and its variants lies in the MPR technology itself, commonly and inaccurately referred to as the "polygraph," regardless of the deception paradigm (GKT, CQT, or others) used with it. MPR measures blood pressure, heart rate, respiratory expansion of the chest, and galvanic skin response (GSR) or skin conductance response (SCR). All of these are mediated by the peripheral nervous system and are correlates of anxiety or arousal. Since deception is a cognitive phenomenon that takes place in the brain, the potential of the MPR in a lie—detection system is theoretically inferior to the more proximal, central nervous system (CNS) correlates of brain activity that could be obtained by EEG and fMRI.[36] Remarkably, one group likely to be overrepresented in the polygraphers' offices are individuals with antisocial personality disorder, that may be associated with an abnormally low MPR response to stress.[37-40] Furthermore, research on the limitations of the accuracy of the polygraph in other special populations, such as psychiatric patients, is surprisingly limited, considering its widespread use and despite clear evidence of an abnormal autonomic system in schizophrenia and other psychiatric disorders.[41] Thus, the expectation that since brain imaging measures are more accurate than the polygraph because they are correlates of the central rather than peripheral nervous activity, remains to be confirmed experimentally, in the laboratory and then in controlled clinical trials in relevant populations.

Brain imaging

Evoked related potentials (ERP) and brain blood flow have also been used in the study of deception.[42-46] Critical components of a brain-behavior correlation study include a symptom provocation paradigm, closely following the definition of the behavior in question, as well as a measurement technique, such as skin conductance, electrical brain activity or a functional map of cerebral metabolism or blood flow.

Magnetic Resonance Imaging (MRI) is one of the most widely used noninvasive methods of medical imaging. MRI is based on signals emitted by atoms that have been perturbed by strong magnetic fields. Briefly, the imaging contrast in MRI is derived from radiofrequency signals emitted by the hydrogen atoms in the tissue, placed in the strong (main) magnetic field and intermittently perturbed by other, smaller magnetic fields (gradients) applied at an angle to the main field. An MRI scanner is a large superconducting magnet with a central bore, to accommodate the patient, equipped with additional electromagnetic coils capable of producing a smaller rapidly shifting gradient field. MRI scanners are usually described by the strength of the larger "main" magnetic field, expressed in Tesla (T). One Tesla is x 10,000 the force of gravity. The field strength of modern clinical MRI scanners is between 0.35 and 3T. Functional MRI is a variant of MRI imaging fast enough to allow correlation with a behavior of interest, usually on the time scale of seconds.

Field strength above 1T and advanced gradient coils are required for functional MRI. The specific way in which hydrogen molecules are perturbed by the gradient fields, determines which tissue type or physiological process is highlighted. One fMRI technique, aimed at maximizing the signal produced by oxygenated hemoglobin and minimizing the time necessary to obtain an image has been dubbed Blood Oxygenation Level Dependent (BOLD) fMRI.[47] BOLD fMRI can be used to track the changes in blood flow that correspond to changes in local brain activity and is the premiere tool of research focusing on the brain activity correlates of particular behavior. BOLD fMRI is the imaging technique used in most neuropsychological studies, so that an fMRI study could be assumed to be BOLD fMRI, unless stated otherwise. Similarly to the polygraph, which consists of an MPR and a paradigm designed to elicit a behavior of interest (deception), fMRI experiment consists of the recording device (MRI scanner) and a symptom provocation paradigm. Because of the small effect size of the fMRI response during cognitive activity, multiple observations of each target behavior ("conditions," e.g., "lie" and "truth") are needed for subsequent correlation between a condition and the BOLD fMRI signal it may have produced. Similarly to the polygraph, the magnitude of BOLD fMRI signal is only meaningful in relation to a baseline that needs to be established for each "condition" of interest.[48] Thus, the choice of a valid baseline condition in a behavioral fMRI experiment is as critical as the determination of baseline signal in response to a "probable truth" or a "probable lie" in a polygraph examination.

For example, comparing a brain response to a relevant question about a crime with response to a blank screen would always yield significant differences, which would be meaningless because blank screen is not a valid comparison to a question about a crime, even if the suspect has not been involved in it. In our vignette, Ms. A's delusion was improbable enough to be deemed a "probable lie." The polygraph then produced a probable false negative result with a "probable lie." Remarkably, had the polygraph been reliable, such a result could be used to diagnose a delusional state.

Though the number of variables needed to describe a specific deception variant is seemingly endless, a few emerge as key variables defining a type of deception: Those include endorsement of deception by the investigator, presence of a target for deception, assumption of secrecy of the deception by the deceiver and the intent.[49] Though these parameters are consistent with the consensus definitions of deception (see above), laboratory deception experiments differ in their ecological validity, e.g., degree to which they approximate the "real-life". Since 2001, studies using BOLD fMRI, employed a variety of deception paradigms of increasing ecological validity. Despite the paradigm variability, the findings overlap significantly. The key conclusion from the initial studies was that the cognitive differences between deception and truth have neurophysiological correlates detectable by fMRI.[50] Subsequent series of studies confirmed the involvement of the medial anterior prefrontal cortex and the bilateral inferior lateral and superior parietal gyri in deception. These studies demonstrated that the effect previously observed at a group level, could be detected in single subjects and even single events of lying.[51-55] Moreover, the fact that the activation related to truth-telling tends to locate posterior to the activity during lie,[56] supports the prediction,[57, 58] that deception is a more complex and working memory-intensive task than truth.[59] The implication of these observations is that a response could be classified as lie by the pattern of brain activity it produced, regardless of whether it is objectively true or false. Essentially, a response would be classified as lie or truth based solely on responders' (internal) point of reference, objectively demonstrated by fMRI or other CNS measure.

Several critical aspects of neurobiology of deception have not yet received sufficient attention. First is the effect of countermeasures on the accuracy of lie-truth discrimination.[60]

A wide variety of countermeasures could be used to sabotage lie-detection, including pharmacological interventions that are outside of the scope of this article. Ganis et al., was the first to explore the effect of rehearsal on the fMRI pattern produced by a lie.[61] Rehearsal and practice are of particular clinical importance, since they are used by both attorneys and therapists to modify their clients' behavior and sometimes, memories.[62-64] Data on the CNS effects of cognitive countermeasures on the central nervous system correlates of deception suggests that countermeasures are likely to attenuate, but not prevent, lie-truth discrimination.[65-67] Second, none of the brain imaging studies of deception parametrically manipulated the risk/reward ratio of deception, which could be much higher in real life situations than in standard laboratory experiments. Expanding the findings from healthy controls to a range of special populations would also require additional experimental support.

Finally, a legally important aspect, that has received little attention from neuroscientists studying deception, is the concept of deception as a social or "theory of mind" behavior. Theory of mind, also called meta-cognition, has been defined as "thinking about thinking" or "thinking about what someone else is thinking."[68] Monitoring one's social interactions for potential deception is a private case of individual's "theory of mind."[69] The jury interaction with plaintiffs, defendants and their attorneys is also an example of multiple "theory of mind" processes. Brain imaging studies, with participants trying to detect deception rather than to deceive, indicate that theory of mind may have characteristic patterns of brain activity.[70]

Subjective reality, memory retrieval and delusions

Memory is not static: Strong preclinical evidence indicates that it is reconsolidated after each retrieval, leaving it open to modification by rehearsal, type of query or pharmacological agents that could interfere with reconsolidation.[71-75] Moreover, preliminary clinical evidence indicates that memory retrieval and reconsolidation could be affected by collateral unconscious mechanisms, particularly when there is an emotional correlate or tag to a particular memory component.[76] While the act of deception requires conscious awareness and intent, the process of recall and reconsolidation of a memory could be entirely unconscious.[77] Together, the brain imaging data on recall and deception support the following hypothetical neural cascade of deception. There are two parts: The "reality testing" segment and the "behavioral control" segment. The first is a partially unconscious process of data retrieval and coherent narrative formation,[78, 79] which then passes into awareness. The second is a conscious decision to "release," "suppress," or "suppress → replace the narrative → release." Thus, intentional deception can only take place during this relatively brief, conscious stage of what is essentially a general utterance generation process. This model allows a prediction of the temporal and spatial pattern of brain activity during the process of deception; during the "reality testing" segment, the pattern of brain activity will be that of recall and narrative formation,[80, 81] while the behavioral control stage would be similar to other situations requiring regulation of behavior.[82-84]

Recall can be modulated by unconscious input from multiple Brain Areas related to individuals' prior learned experiences as well as the unconditional response patterns.[85] Anatomically, the extended limbic system is likely to be involved in this process.[86] This model is congruent not only with the recent reports on suppression of unwanted memories and true and false recall, but also with the classical dynamic theories of conscious and unconscious and the unconscious defense mechanisms.[87-89] Within this model, a delusion would be indistinguishable from truth with either psychophysiological or brain-based lie-detector system, but could have a different brain signature during the "reality testing" stage of deception. Recent data indicate that while both true and false recall involve semantic trace retrieval, only true recall involves sensory trace retrieval.[90, 91]

Conclusion

Theoretically, delusions and other impairments in reality testing that are indistinguishable from the truth on the cognitive level could be inaccessible to either the polygraph or brain-imaging based lie-detection. Experimental data from well-controlled experiments on psychophysiological lie-detection in delusional subjects are required to confirm or refute this assumption. We hypothesize that in delusional patients, brain activity patterns range from those typical of deception (medial and lateral anterior frontal cortex) to those characteristic of truth (posterior parietal). Such data could lead to new, functional definition of a delusion as an objectively false belief that has a brain signature of truth and produce a novel method of neurophysiological monitoring of the development of "insight" both in psychotic and nonpsychotic patients. Successful treatment would be associated with a change in the brain patterns associated with a delusion or a pathological defense from "truth" to "lie." Another broader implication of the proposed experiments would be an estimate of the reliability of psychophysiological investigations in non-psychotic subjects with firmly-held beliefs.

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