The Anatomy of Deception: A Literature Review of the

Neurobiological Basis, Underlying Cognitive Processes,

and Motivations that Facilitate Lying

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Abstract

Deception is a cognitive-demanding process that entails more than one executive function and is thus associated with an increase in neural activity in specific regions of the brain. The purpose of this review of literature is to highlight the neural networks that facilitate deception, in addition to identifying the motives and conditions that increase one's likelihood to deceive. This research aims to discuss the neuropsychological evidence of brain structures that subserve human deceptive behavior, especially with an emphasis on the role of the prefrontal cortex and its executive functions. This research is of importance to the field of psychology, as it offers insight into the nature of deception by considering the neural processes involved in different aspects of deception, such as the preparation to lie, intention, and context that is eliciting the need or likelihood to resort to deception. This review of literature will further advance neuroimaging research, because it contributes to the ongoing discussion regarding neuroimaging techniques as a valid instrument for deception detection in the fields of forensic psychology and psychiatry.

Introduction

Deception is a psychological process by which an individual makes a "deliberate attempt to create in another a belief which the communicator considers to be untrue" with the intention to mislead (Levine, 2014; Vrig, 2001), typically to gain benefits or to avoid aversive consequences (Ito, Abe, Fujii, Hayashi, Ueno, Mugikura, Takahashi, & Mori, 2012). Deception may manifest in the form of a lie, or an "intentional distortion of event knowledge, generally aimed at instilling a false belief" (Ekman & O'Sullivan, 1991). Human interaction relies on coordination, cooperation, and communication, and thus requires an assumption of honesty; however, there are instances when one abandons this assumption and resorts to deception (Levine, 2014). As a consequence of evolution (Trivers, 2011), deception has become a feature of human communication, with human beings carrying a more advanced capacity to lie and being more proficient at it compared to other mammals (Spence, 2004). Evolutionary explanations propose that humans have become more adept because those who employ deception may become more successful with reproduction, compared to those who are truthful (Raine, 2013). With this considered, deception is socially adaptive, as it may be employed for purposes, such as self-concept maintenance (Hirschfeld, Thomas, & McNatt, 2008), impression management (Lonnqvist, Irlenbush, & Walkowitz, 2015), and even to prevent deception detection (Lu & Chang, 2014).

Regardless of the purpose, resorting to deception suggests that one must instantaneously execute more than one cognitive process, including generating a deceptive response that is contrary to the determined truth, suppressing behavioral and emotional indicators of deception, and inhibiting the truth (Ofen, Whitfield-Gabrieli, Chai, Schwarzlose, & Gabrieli, 2017). With this considered, deception is not a single cognitive process but rather a complex one that

comprises of a series of executive functions that must be simultaneously stimulated. It is distinctive from the neural circuits that enable telling the truth (Spence, 2004), and different types of lies are associated with different patterns of neural activation (Ganis, Kosslyn, Stose, Thompson, & Yurgelun-Todd, 2003).

A growing body of literature surrounding deception has thus emerged to investigate deception detection techniques and the neurobiological basis of deception (Priori, Mameli, Cogiamanian, Marceglia, Tiriticco, Mrakic-Sposta, Ferrucci, Polezzi, & Sartori, 2008; Spence, 2004). Furthermore, neuroimaging techniques, including functional magnetic resonance imaging (fMRI) and positron emission tomography (PET), have identified the neural correlates involved in the process of inhibiting true responses and generating deceptive responses (Abe, Fujii, Hirayama, Takeda, Hosokai, Ishioka, Nishio, Suzuki, Itoyama, Takahashi, Fukuda, & Mori, 2009; Ito et al., 2012). In doing so, researchers can inform an understanding of the cognitive and neural mechanisms involved in deception (Ofen et al., 2017). This research aims to identify the neural correlates of deception and thus implicate it as a cognitive-demanding task, ultimately contributing to the growing body of literature surrounding deception and neuroimaging research.

Literature Review

Self-Deception

Self-deception is the practice of convincing oneself to either believe a false idea is true or deny the truth, as to avoid revealing the true nature of his or her motives (Lu & Chang, 2014). According to Trivers' (2011) theory of self-deception, individuals deceive themselves in order to deceive others by temporarily storing truthful information in the unconscious while consciously presenting false information to others. In doing so, one can prevent deception detection from others (Trivers 2011), because even the deceiver is unaware of his or her ongoing deception.

Evolutionary explanations propose that self-deception evolves to better escape deception detection, thus prompting the individual to be conscientious of and respond to social conditions that suggest the probabilities of deception detection (Lu & Chang, 2014). Therefore, there are certain detection-registering conditions that influence the likelihood that one should resort to self-deception.

Social status. Individuals are more likely to resort to self-deception to prevent deception detection from higher- rather than equal-status others, which suggests that self-deception responds to a status hierarchy (Lu & Chang, 2014). Furthermore, individuals of lower status are more likely to be deceivers, as opposed to those of higher status who are more likely to be detectors (Lu & Chang, 2014). This may be the case, as humans live in a hierarchical social group where status influences resource distribution (Boehm, 1999; Raine, 2013), so those of low-status are more motivated to deceive, whereas those of high-status are more motivated to detect deception (Lu & Chang, 2014). There is thus an increase in pressure for those of lower-status to prevent deception detection, and Trivers (2011) proposed that one may resort to self-deception to temporarily store truthful information in the unconscious mind and present only falsehoods to others.

Self-concept maintenance

Self-concept reflects the way that an individual views and perceives themselves, and serves as a motivating force for them to perform specific behaviors to maintain or enhance that construct (Hirschfeld et al., 2008). Self-enhancement refers to the tendency or motivation for individuals to attribute their successes to internal factors while rejecting or ignoring external factors (Hirschfeld et al., 2008). From a psychological perspective, individuals internalize the

values of their society, which then serve as an internal benchmark against which an individual compares his or her behavior (Mazar, Amir, & Ariely, 2008). Individuals are thus motivated to create and manage impressions of themselves in a socially desirable manner (Farrow, Burgess, Wilkinson, & Hunter, 2015). Coupled with self-deception, this preference may bias an individual's performance and drive them to behave in specific ways, including deceiving themselves, as a means of maintaining a positive self-concept and self-esteem, and achieving social desirability.

However, there are cases when an individual desires to project the impression that they are moral than would be justified by their behavior, but fail to comply with their internal values systems (Lönnqvist et al., 2014). Moral hypocrisy refers to the motivation to project oneself as moral, but avoid the cost of actually behaving morally; however, such insincerity manifests awareness that one is acting immorally, which ultimately threatens one's self-concept (Lönnqvist et al., 2014). If an individual fails to comply with their internal, moral standards, then they will need to update their self-concept in a negative manner, which is aversive (Mazar et al., 2008). This generates cognitive dissonance between resorting to deception but at the expense of maintaining a positive self-concept that one is more moral than would be justified by his or her behavior (Mazar et al., 2008; Lönnqvist et al., 2014). Self-deception is thus used as a means to suppress this awareness so that the individual can proceed with their moral misbehaviors without compromising their self-concept in the process (Lönnqvist et al., 2014). With this considered, the likelihood to self-deceive in order to maintain self-concept is increased when the individual is in a scenario that threatens their self-esteem or positive self-concept.

On the other hand, Mazar et al. (2008) revealed that self-concept maintenance may also prevent one from self-deceiving, as investigated through whether individuals would cheat after

considering the Ten Commandments. The results revealed that participants did not cheat after the Ten Commandments recall task, thus creating a significant interaction between the type of reminder and ability to cheat (Mazar et al., 2008). In fact, participants' performance in the Ten Commandments condition was undistinguishable from those in the control conditions, which supports the role self-concept maintenance and that being reminded of standards for morality eliminated cheating to a significant degree (Mazar et al., 2008). Aligned with Lönnqvist et al.'s (2014) findings, intrinsic and extrinsic motivational dispositions are underlying factors associated with self-deception (Hirschfeld et al., 2008). In this case, an intrinsic motivational disposition reflects ego enhancement, and an extrinsic motivational disposition reflects ego defensiveness. Hirschfeld et al. (2008) revealed that self-deception was positively correlated with intrinsic motivational disposition but negatively related to extrinsic motivational disposition, which suggests that there is a stronger tendency to self-deceive when framing one's performance as originating from internal rather than external motivations.

Truth-default theory. Levine (2014) proposed the Truth-Default Theory (TDT) which states that humans operate on a default presumption that people are honest, thus making them vulnerable to deception when one abandons this presumption. There are conditions under which one is typically honest, but this may concurrently increase the likelihood that someone else will engage in deception (Levine, 2014). This aligns with the findings of Lu and Chang (2014) and Hirschfeld et al. (2008) with regards to social status and self-maintenance representing these conditions.

<center>Neural Networks of Deception</center>

Research surrounding brain activation associated with deception, as measured by functional magnetic resonance imaging (fMRI), magnetic resonance imaging (MRI), F-

fluorodeoxyglucose PET (FDG-PET), and transcranial direct current stimulation (tDCS), has revealed that deception is associated with higher activation in specific brain regions (Ofen et al., 2017). This is the case, for deception comprises of more than one executive function and thus requires increased neural processing in order facilitate these executive functions (Raine, 2013).

Executive control refers to a set of processes that are essential to the cognitive control of behavior, and include problem solving, planning, and reasoning (Carrion, Keenan, & Sebanz, 2010). These processes are necessary towards selecting behaviors that facilitate the attainment of goals, such as effectively deceiving. Executive control further entails information processing in order to assess specific behaviors appropriate for the current situation or goal, inhibit responses, and maintain relevant contextual information that may assist in facilitating certain behaviors (Carrion et al., 2010). In doing so, the individual can process new input that may signal a change in task and thus adjust their behavior accordingly. Therefore, executive control allows an individual to produce, maintain, or switch a response when driven by a task instruction, context, reward, or goal, all of which are necessary components to facilitate deception. For instance, working memory maintains the truth in mind while generating a deceptive response, inhibitory control suppresses the truth while executing the lie, and task switching allows alternating between truthful and deceptive responses (Christ, Van Essen, Watson, Brubaker, & McDermott, 2009). In fact, there are specific regions in the brain that facilitate these components.

Previous and current functional neuroimaging methods surrounding the investigation of deception rely on contrasting lying with truthful responding, in order to generate a cognitive subtraction (Spence, Kaylor-Hughes, & Wilkinson, 2008). In doing so, prior research has identified brain regions involved in the underlying cognitive processes that enable executive functions that in turn facilitate deception (Lu & Chang, 2014; Ofen et al, 2017; Raine, 2013).

These findings support how increased neural activity and connectivity within specific brain regions enable deception, as exhibited by functional anatomical responses.

Prefrontal cortex

As previously mentioned, self-deception evolves to better escape deception detection (Trivers, 2011), for even the deceiver is unaware of his or her ongoing deception. The individual will thus lack behavioral indicators of deception, such as fluctuations in voice volume and pitch, facial contractions, and constricted body movements (Lu & Chang, 2014). The prefrontal cortex facilitates this suppression by inhibiting behaviors regulated by the motor and sensorimotor cortices and limbic system that may indicate deception (Lu & Chang, 2014; Raine, 2013). The prefrontal cortex is thus associated with increased cognitive activity, in order to facilitate these suppressions (Spence et al., 2008). Therefore, despite a lack of behavioral displays, deception still manifests as physiological and neural activity. Coupled with increased neural activation, delayed reaction times are associated with deception (Farrow et al., 2015), which supports the notion that deceptive behavior is cognitively demanding, especially in portions of the prefrontal cortex (Spence et al., 2008). Raine et al. (2013) further revealed that the prefrontal cortex is associated with an increase in white matter volume in individuals considered to be pathological liars, compared to individuals in the control group.

Research surrounding Parkinson's disease supports the role of the prefrontal cortex, as patients with the disease express difficulty with successfully generating deceptive responses, compared with healthy individuals (Abe et al., 2009). F-fluorodeoxyglucose PET (FDG-PET) imaging revealed that Parkinson's disease is correlated with hypometabolism in the prefrontal cortex (Abe et al., 2009). This may be on account of the prefrontal cortex being involved in inhibiting truthful responses and producing deceptive responses (Hooker & Knight, 2006); thus,

a dysfunction of the prefrontal cortex, as observed in patients with Parkinson's disease, results in difficulty engaging in deceptive behaviors (Abe et al., 2009). These results further support how the prefrontal cortex facilitates the generation of deceptive responses. Therefore, the prefrontal cortex plays an important role in deception; in fact, it comprises of regions that may be functionally and anatomically distinct (Christ et al, 2009). Christ et al. (2009) revealed at least eight deception-related regions within or surrounding the prefrontal cortex, including the ventrolateral and dorsolateral prefrontal cortices.

Ventrolateral prefrontal cortex

Prior functional neuroimaging studies have revealed that the left ventrolateral prefrontal cortex (vlPFC) is one of the regions in the brain that is activated during lying, compared with telling the truth (Spence et al., 2004; 2008). Specifically, the vlPFC maintains goal-directed behaviors by filtering out potentially distracting stimuli and perceptions, suppressing inappropriate and truthful responses, and learning new contingencies (Hooker & Knight, 2006; Spence et al., 2008), all of which is necessary for deception. It has been further reported that the vlPFC is activated during intentional lying, which involves inhibiting competing responses, error checking, and self-monitoring of performance (Farrow et al., 2015). As previously mentioned, deception responds to a status hierarchy (Lu & Chang, 2014) and is involved with impression management (Farrow et al., 2015). The vlPFC facilitates these functions by judging social hierarchies and using those judgments to select the appropriate impression to project (Farrow et al., 2015). Thus, the vlPFC primarily harnesses neural activity in order to inhibit truthful or inappropriate responses as a function of deception.

Dorsolateral prefrontal cortex

The dorsolateral prefrontal cortex (dlPFC) has been implicated with executive functions, such as working memory (Priori et al., 2008), appropriate response generation (Ito et al., 2012), and resolution of response conflict (Abe et al., 2009), all of which contribute to deceptive processes. Ito et al. (2012) explored the neural basis of the preparatory processes that underlie deception, and identified the role of dlPFC when it was active during the preparation of both deceptive and truthful responses. This suggests that both tasks demand similar preparatory responses; however, the dlPFC maintained its increased neural activity during the execution of deception, compared to truth-telling (Ito et al., 2012). In accordance with these results, Priori et al. (2008) used transcranial direct current stimulation (tDCS) to manipulate the functions of the dlPFC, which consequently altered the speed and efficiency of deceptive response generation. Therefore, the dlPFC is involved with deception preparation, but also contributes to the production and generation of deceptive responses (Abe et al., 2009; Ito et al. 2012).

Furthermore, the dlPFC is associated with deception of episodic memory, regardless of its emotional disposition (Ito, Abe, Fujii, Ueno, Koseki, Hashimoto, Mugikura, Takahashi, & Mori, 2011). Ito et al. (2011) revealed that deception related to recalling neutral pictures was associated with an increase in neural activity in the dlPFC, but also the ventrolateral prefrontal and orbitofrontal cortices. However, the dlPFC was also associated with deception related to recalling emotional content, which suggests that the dlPFC is associated with the executive functions that facilitate deception (Ito et al., 2011).

Medial prefrontal cortex

Carrion et al. (2010) revealed an increase in neural activity in the medial frontal lobe (mPFC) when individuals were either cued or commanded to have deceptive intentions, regardless of whether he or she was lying or telling the truth. This may be the case, because of theory of mind, or the executive ability to consider inferences about the perspective of others and empathize (Karim, Schneider, Lotze, Sauseng, Braun, & Birbaumer, 2010). The individual must manage both their own mental state in additional to that of another, so an increased cognitive control is needed to keep both perspectives apart (Carrion et al., 2010). Even though the purpose for deception was unconscious, as was the case for the participants who were cued to have deceptive intentions, there was still evidence of increased activity in the mPFC (Carrion et al., 2010). Therefore, deception does not necessarily have to be consciously intentional (Levine, 2014). Furthermore, the mPFC is associated with self-identity and enhancement, emotional processing, and when attention is directed at the self, thus supporting the notion that self-concept maintenance and impression management may increase the likelihood of deception (Farrow et al., 2015; Hirschfeld et al., 2008).

Conclusion

In the final analysis, the results indicate that deception is a cognitive-demanding process, as it requires more than one higher, executive function, as facilitated by the prefrontal cortex. One may resort to self-deception, and deceive themselves in order to escape deception detection from others, for he or she will lack behavioral and emotional indicators of their ongoing deceit (Lu & Chang, 2014). There are deception-registering conditions that may increase the likelihood that one will deceive, such as social status and self-concept maintenance. Specific portions of the prefrontal cortex, including the ventro-lateral and dorsolateral prefrontal cortex, facilitate

different aspects of deception, such as inhibiting truthful responses and generating deceptive responses, respectively. Coupled with reduced reaction times, increased activation in these portions of the prefrontal cortex support the notion that deception harnesses neural and cognitive activity, in order to be successfully executed.

One of the limitations of this research is that deception was stimulated for the purpose of conducting a laboratory experiment, which questions whether this is equivalent to actual deception. In addition, each study operationalized deception in a different manner. Another existing limitation is that prior research thus far has used only group analyses. With this considered, future research should consider replicating the research studies addressed in this review of literature in a more natural and realistic setting. Further research into deception detection would benefit from examining whether fMRI and other neuroimaging techniques can identify reliable neural signatures of deception in single and unique individuals, as opposed to solely groups. Nonetheless, considering the ongoing advancement of neuroimaging techniques, past and current research have contributed to the pursuit of anatomically and functionally mapping the brain, and investing the truth about lying.

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