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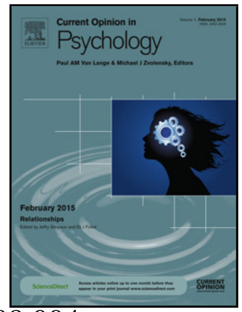

Title: The Physiology of (Dis)Honesty: Does it Impact Health?

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Highlights

- Dishonesty recruits executive control areas of the brain.
- Dishonesty is positively associated with testosterone, and cortisol reactivity.
- Dishonesty increases arousal, blood pressure, and heart rate.
- Innocent observers of dishonesty may experience similar physiological effects.
- These physiological effects can have negative health outcomes.

The Physiology of (Dis)Honesty: Does it Impact Health?

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Abstract

Research suggests that dishonest acts may be embodied. That is, when a person anticipates or acts dishonestly, the choice or behavior is not only reflected in the mind but also in the brain and body. While recent summaries of virtuous acts suggest that truth, altruism, and fairness confer a suite of psychological and health benefits to the benefactor, we suggest that lying, cheating, and stealing may do the opposite. We review research literatures on the neuroscience, psychophysiology, and endocrinology of dishonesty and suggest that, over time, dishonest behavior may be bad for our health.

Emerging research is demonstrating that dishonest acts are accompanied by distinct physiological signatures. In fact, evidence suggests that before, during, and after a dishonest act, there are physiological residues evident in the brain, body, and biology. These data suggest that dishonest acts can *get under our skin* and are thus *embodied*. When a human experience is embodied, it typically exerts deeper effects on both short and long term health. Here, we draw links among the existing literature on the physiology of (dis)honesty and make the argument that dishonesty is bad for our health. We start by summarizing both canonical and newer work demonstrating the ways in which dishonest acts affect brain, body and biology. We then go beyond the perpetrators of dishonesty and describe emerging work on the physiological impact of perceiving dishonest acts. In summary, data suggests that engaging in and observing dishonesty is bad for your health (see Figure 1 for a summary of evidence connecting dishonesty and negative health consequences).

The Physiological Experience of Engaging in (Dis)Honesty

Some people live virtuous lives. They donate their precious time to charity, tell the truth, remain loyal to friends, faithful to spouses, and pay their taxes as expected. Other people live very different lives—they take charity when they do not need or deserve it, they lie, cheat, exploit, and steal. While there are some "bad apples" in the world, what modern science tells us is that the road to dishonesty boils down to features of the *situation* and features of the *decision* [1,2]. The structural aspects of our physical and cultural environments that promote dishonesty need to be understood so that we can prevent these forces from encouraging dishonesty. A thorough review with prescriptive advice can be found in [2]. However, this paper is concerned with the latter feature—the *decision moment*. At that crossroads, a number of psychological and physiological inputs are rapidly considered including cues from the context, episodic memory, ethics, and *feelings*—both consciously experienced and labeled emotional states [3] and physiological signals pulsing beneath the skin, which, may or may not be consciously experienced [4]. In this short review, we focus on measurable biomarkers harvested from the brain (e.g., functional MRI differences), body (e.g., heart rate, cardiac efficiency) and biology (e.g., cortisol) along a temporal continuum from anticipation of a dishonest act to retrospective recall of a misdeed (see Table 1 for a list of key terms and definitions). These biomarkers are generally associated with ill health, as illustrated by links to the health literature.

(Dis)Honesty in the Brain

Recent advancements in technology have allowed researchers to measure activity in the brain when it is engaging in a dishonest act. Along the temporal continuum from anticipation to retrospective memory, evidence suggests there are some functional MRI differences between the brains of dishonest versus honest actors. For example, as a lie is just starting to take shape and before it is uttered, the anterior cingulate cortex tends to be active [5,6]. During the dishonest act, areas associated with executive control are engaged; the dorsolateral prefrontal cortex and posterior parietal cortex inhibit truthful responses and provide working memory resources, while the ventrolateral prefrontal cortex, anterior insula, and the anterior cingulate cortex tend to subserve executive control functions [7-9]. Interestingly, the neural regions recruited appear to be moderated by lie-type. For example, spontaneous-isolated lies disproportionately recruit regions such as the anterior cingulate, extending into the left premotor cortex, the left precentral gyrus, the right precentral/postcentral gyrus, and the right cuneus. In contrast, memorized-scenario lies recruit only the right anterior middle frontal gyrus [10]. After a dishonest act occurs, electroencephalography (EEG) recordings can indicate the recollection of lie-relevant stimuli [11]. Specifically, researchers used a paradigm in which participants lie or tell the truth about having been previously exposed to a stimulus, finding that the P300 component of the event-related potential in EEG brain waves revealed when a participant had actually seen a stimulus previously—even when they insisted they did not [12,13]. In general, however, not a great deal of research has investigated links between dishonesty and the brain. For a thorough review and description of good future directions, see Sip and colleagues [14].

While the study of dishonesty and the brain requires additional attention, a synthesis of the results to date make it clear that executive control regions tend to be engaged and taxed when telling lies. Generally speaking, depleting precious cognitive resources debilitates the ability to effectively use cognitive resources for other purposes including the down-regulation of stress and up-regulation of other healthy, homeostasis-preserving parasympathetic responses—especially after a lifetime of chronic attempts at regulation [15]. In addition, suppression of these regions has been associated with decreases in empathic responding [16].

(Dis)Honesty in the Body

Acts of (dis)honesty also leave their mark on the way in which our bodies and internal physiology work. Deep links between virtuous behavior and the human mind and body suggest that acts of (dis)honesty are embodied. That is, when a person anticipates or engages in a moral or dishonest act, it is reflected in embodied ways such as changes in heart rate, respiration rate, and skin conductance. Changes in these physiological markers can directly impact health. For example, when we engage in small acts of honesty or virtue, our positive emotions surge [17] which can serve to down-regulate disorders of hyper-arousal such as anxiety [18]. Such acts can also lead directly to health benefits such as lower blood pressure and increased longevity [19-22]. Brown and colleagues [23] suggest that the release of the hormone oxytocin (OT) may be one mechanism through which acts of virtue promote health by reducing levels of corticosteroids and blood pressure [24].

In contrast with acts of virtue, dishonesty is generally associated with negative physiological changes. Early scientific explorations of how physiology could reveal a liar were focused on the "polygraph"—a combination of physiological measures, usually including skin conductance, blood pressure, and respiration rate, during a structured deception interview. Popular question techniques include the Comparison Question Technique (CQT) [25] and the Guilty Knowledge Test (GKT) [26]. Both compare physiological reactivity to critical questions about the transgressions as compared to reactivity to baseline arousal. Generally, telling lies is associated with heightened arousal, resulting in increased skin conductance and slower skin conductance recovery, increased blood pressure, heart rate acceleration, respiration rate, and pupil dilation [27-29]. Chronically elevated heart rate and blood pressure can lead to higher C-Reactive Protein, thyroid disorder, diabetes and other indices of metabolic syndrome [30].

(Dis)Honesty in Biology

Links between the neuroendocrine system and (dis)honesty are just beginning to emerge. One neuroendocrine hormone, testosterone, appears to be linked to a number of behaviors directly or indirectly related to (dis)honesty. Testosterone is an anabolic, or "cell building" hormone that is present in both of the sexes. Generally speaking, research in behavioral endocrinology suggests that freely-available testosterone is associated with diminished sensitivity to the affective signals which facilitate pursuit of empathic behaviors and choices [31-33]. Carney and Mason [34] showed that MBA students higher on daily levels of testosterone were more likely to endorse murdering someone directly (with their bare hands) or indirectly as long as it would save other lives. Other research shows that testosterone is linked to a higher tolerance for risk [35] and an insensitivity to punishment [36] which could further encourage dishonest acts. In fact, testosterone has also been found to encourage pursuit of antisocial strategies such as rule violations and antisocial behavior [37].

Another kind of testosterone—the kind that is present as a baby is developing in the womb—is linked to a number of dishonest behaviors. Specifically, high levels of testosterone exposure in utero, mediated by hyper-masculine facial features, predicts sexual infidelity [38], aggression [39], exploitation [40], and cheating and deception [41].

Cortisol too, has with links to dishonesty. Cortisol is a catabolic (i.e., cell "breaking-down") hormone with links to chronic stress, systemic inflammation, increase in CRP, cellular death and generally poor primate (human and non-human) health [42,43]. While cortisol is part of an adaptive system supporting mobilization—especially in the face of a threat—chronically elevated or poorly regulated cortisol is detrimental to health. Dishonest acts such as deception are linked to increases in cortisol. Specifically, liars experience stronger cortisol reactivity than truth-tellers when verbally recounting a potential transgression [44,45]. Also, cortisol mediated the relationship between experimentally-manipulated unfairness and unethical behavior, with higher levels of cortisol associated with greater likelihood of retaliatory, unethical behavior [46].

Based on accumulating evidence that links freely-available hormones to dishonesty, a recent study has also examined whether testosterone and cortisol can jointly influence one's likelihood of engaging in dishonest acts [47]. The endocrine profile that maximizes the likelihood of dishonesty was a combination of high testosterone coupled with high cortisol. This research supports the idea that cheating may in fact be one way that individuals could manage performance anxiety and reduce an aversive, unhealthy state of having high cortisol by exerting control over the outcomes.

The Detrimental Physiological Effect of Merely Observing (Dis)Honesty

It is easy to imagine that dishonest acts can leave an unhealthy mark on one's brain, body, and biology. But our dishonest acts do not happen in a vacuum—others around us see us cheat and steal. Are merely passive observers victimized by our dishonest actions? Emerging research suggests the answer to that question is "yes." ten Brinke, Lee, and Carney [48] demonstrate that merely viewing someone lying about not having committed a murder (versus telling the truth) causes two distinct physiological changes: increases in arousal as evidenced by upward shifts in electrodermal activity (EDA) and decreases in cardiac efficiency as evidenced by blood flowing away from the periphery in a threat-like reaction. The adaptive utility of such a reaction is to send the blood to the heart and other vital organs because these physiological responses signal to the observer there is a danger in the environment. Both increases in EDA and vasoconstriction are associated directly and indirectly to negative health outcomes as described previously. More generally, the negative physiological reaction occurring in the (dis)honest actor may be contagious to observers. Indeed, recent research suggests that physiological experiences are contagious also [49]. As such, the negative health effects of a dishonest actor may extend far beyond his or her own body.

Conclusion: Dishonesty (Acting and Perceiving) is Bad for Your Health

On one hand, telling the truth, being altruistic, acting fairly and being generally other-oriented are virtues directly linked to a suite of positive health outcomes such as: better health and physical wellness, lower stress, decreased cellular aging, increased psychological well-being and longevity of life. On the other hand, lying, being selfish, cheating, and engaging in infidelity are associated with a suite of negative health outcomes such as elevated heart rate, increased blood pressure, vasoconstriction, elevated cortisol, and a significant depletion of the brain regions needed for appropriate emotional and physiological regulation. The direct downstream consequences from dishonesty on long-term damage to brain, body, and biology is unknown; however, a great deal of research exists already suggesting strongly that events causing bio-insult in the short term inevitably result in longer-term damage. We invite future research that directly examines the long-term effects of dishonesty on health.

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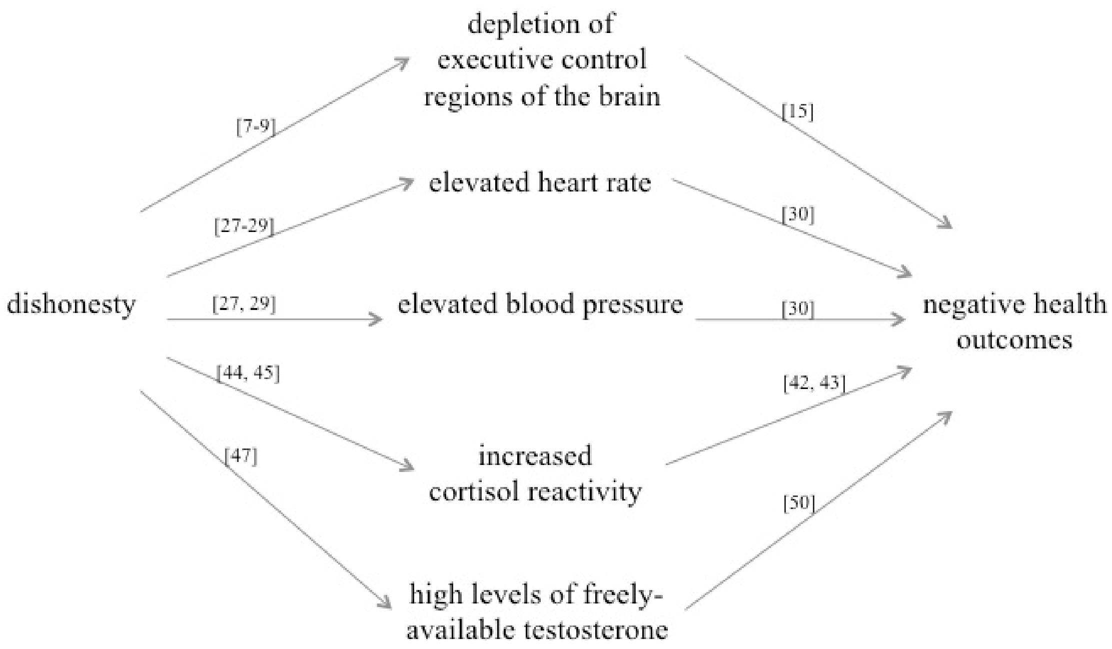

Figure 1. Summary of empirical research supporting the link between dishonesty and negative health outcomes. Numbers in brackets refer to research articles, listed in the References section.

Table 1. Glossary of terms

Term	Description
Brain Regions	
Anterior cingulate cortex	Brain area involved in decision-making, empathy, impulse control, reward anticipation, and emotion
Anterior insula	Brain area involved in consciousness/self-awareness and emotional functioning
Cuneus	Brain area involved in visual and spatial attention, and autobiographical memory
Dorsolateral prefrontal cortex	Brain area involved in cognitive control, conflict monitoring, working memory, and decision-making
P300	A wave that is an event-related potential elicited in the process of decision-making, which reflects processes involved in stimulus evaluation or categorization
Posterior parietal cortex	Brain area involved in receiving input from the visual, spatial, and auditory sensory systems
Precentral gyrus	Brain area involved in executing voluntary movements
Postcentral gyrus	Brain area involved in the primary sensory functions, such as perceiving pain, tough, pressure, and temperature
Premotor cortex	Brain area involved in planning and creating motion sequences and coordination
Ventrolateral prefrontal cortex	Brain area involved in inhibiting the motor activity in the cortex, as well as regulating emotion and memory
Physiology	
Electroencephalography (EEG)	A non-invasive method to record electrical activity of the brain along the scalp by measuring voltage fluctuations resulting from ionic current within the neurons of the brain
Heart rate	The speed of the heartbeat measured by the number of poundings of the heart per unit of time — typically beats per minute (bpm)
Respiration rate	The rate (frequency) of ventilation, that is, the number of breaths (inhalation-exhalation cycles) taken within a set amount of time (typically 60 seconds)
Skin conductance	Electrodermal activity that varies with the state of eccrine glands in the skin, and are controlled by the sympathetic nervous system (indicating psychological or physiological arousal)
Vasoconstriction	Narrowing of the blood vessels resulting from contraction of the muscular wall of the vessels
Biology	
Corticosteroids	A class of chemicals including the steroid hormones and involved in a range of physiological processes such as stress and immune response
Cortisol	A steroid hormone that is elevated in response to physical

	or psychological stress or threat
C-Reactive Protein (C-RP)	A protein found in blood plasma, which rises in response to inflammation
Oxytocin (OT)	A non-peptide hormone secreted by the pituitary gland, which regulates reproductive functions such as childbirth and breast-feeding
Testosterone	A steroid hormone secreted primarily by the testicles of males and the ovaries of females, and is associated with social dominance, aggression, risk-taking, and sexual function