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Lying, Deception, and the Brain

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If they can get you asking the wrong questions, they don't have to worry about the answers.

-Thomas Pynchon

A complete understanding of any neurocognitive function lies in grasping its evolution. That being stated, the three main constructs that we wish to explore (i.e., the brain, evolution, and deception) are so incredibly complex that a true, dare we say honest, understanding is in its infancy. Further, a full analysis of the evolution of the brain and deception across the phylogenetic spectrum would be beyond the scope of this volume though we are aided by the fact that within this volume there is a related review (See Chapter 38; Ganis, Morris, & Kosslyn, 2009; Ganis, Rosenfeld, Meixner, Kievit, & Schendan, 2011; Ganis & Patnaik, 2009; G. Ganis, Kosslyn, Stose, Thompson, & Yurgelun-Todd, 2003). Chapter 38 is a thorough review of the relation between the brain and deception and we assume this chapter will be read in conjunction with that chapter, as well as Chapter 16.

Evolutionary biologists typically reconstruct the evolutionary history of *Homo sapien* through the lens of social pressure and a reciprocating interplay between cognitive abilities, neural system expansions, and increased environmental manipulation which all brought about advanced language, tool making, Theory of mind, and self-awareness. Within this cycle, demands on cooperation were increased as the infant neural system needed a longer time to mature and this new advanced neural system needed increased caloric intake in order to feed it's growing metabolic demands. Out of this system- that placed an extreme value on the quality of offspring rather than quantity, arose both a demand for knowing the hierarchies and other social nuances, and the abilities to manipulate social systems in order to mate, acquire resources, raise offspring, and pass on one's genes (Adenzato & Ardito, 1999). It is

intuitive to think that our of this system arose deception and those individuals that deceived successfully left more descendants than those that did not. Understanding intentionality (i.e., self-awareness and Theory of mind) aided in deception, as we think deception aided in increasing the depth of self-awareness and Theory of mind (Keenan, Rubio, Racioppi, Johnson, & Barnacz, 2005). Other factors, such as deontic reasoning also favored those that were advanced deceivers. As foolish as it would be to ignore social pressures and advanced cognition in evolution of Homo sapien deception, it would be equally foolish to not think that the evolved mechanisms of deception follow a linear trajectory.

You do not need a brain to deceive

Consider the family of Orchidaceae- a lovely magnificent form of life according to many humans. Yet, without a brain or even a hint of a central nervous system (CNS), the Orchid is one incredible deceiver¹ (Gaskett, 2011). Simply and typically, an Orchid can mimic the female of a pollinator species therefore achieving a basic life function, which is successful pollination (Ayasse, Stökl, & Francke, 2011; Jersáková, Johnson, & Kindlmann, 2006; Schiestl, 2005; Waterman & Bidartondo, 2008). In other words, the orchid may send out visual signals that make it look like a female wasp, therefore attracting male wasps. And while the male wasp is duped, the orchid becomes pollinated. Incredibly, there is evidence that mimicking other species within Orchids has evolved independently (Ayasse et al., 2011), and that there is a tremendous interplay between how the Orchid mimics and what and how other species are drawn to successfully pollinate (Gaskett, 2011). By pretending to be (i.e., mimicking) another organism, the Orchid draws attention to itself and receives clear beneficial evolutionary advantages. It is worth pointing out immediately that the notion that deception can occur without a CNS, and that it evolved independently in a family of plants indicates that the evolution story is a muddled one. Even at the Flora

¹ Deception (Leal, Vrij, Fisher, & van Hooff, 2008; Aldert Vrij et al., 2008) here is seen as the non-intentional manipulation of facts, while lying is used to indicate an individual's knowledge of his/her deception. We have used this distinction because it is somewhat common in the literature, as well as common vernacular, but also because it helps to identify that humans likely add unique cognitive features and that self-deception is beyond the immediate purview of the deceiver.

level, there are pressures to deceive, thus if we even dare think we know what those pressures were for human deception to emerge, we are certainly speculating.

This deception is fairly typical in the multicellular domain. Making oneself to be a 'thing' or a species or a sex you are not; to make yourself conspicuous is not uncommon. Batesian mimicry, for example, refers to an animal that is itself quite palatable making itself look like a different species that is highly unpalatable (Cheney & Côté, 2005; Pfennig & Mullen, 2010). Insects will look like other insects so they look LESS like prey. This mimicry is often achieved through visual cuing (e.g., spots, stripes, colors that match an unpalatable species). However, and remarkably, Batesian mimicry is not limited to physical signals, but also behavioral ones as well. Butterflies of one (palatable) species have a similar flight style when compared to another species of butterfly that is less palatable, thus decreasing its likelihood of winding up as prey (Kitamura & Imafuku, 2015).

Another example comes from the ant world, and here we can see a strategy of mimicry in which the deceiver hopes to NOT draw attention to itself by use of deception (Powell, Del-Claro, Feitosa, & Brandão, 2014a). And while, like the Orchid, there are many examples, ants are both great perpetrators (Powell, Del-Claro, Feitosa, & Brandão, 2014b; Wyatt, 2014) and victims of deception (Malcicka et al., 2015; Uma, Durkee, Herzner, & Weiss, 2013). Ants of one species can play 'Trojan Horse' by use of their own signaling with the intent of getting into the nest of another ant species. Ant nests are often rigorously defended, and species known as *Crematogaster ampla* are extremely aggressive. The deceptive species, *Cephalotes specularis*, uses mimicry to break through the defense. The perpetrators mimic the hosts to gain access to the massive home of the *Crematogaster ampla*. The mimics eat the food and follow the food trails of the hosts, thus giving themselves a tremendous advantage (Powell et al., 2014b).

Being a flower, an ant, a butterfly, or even a protozoa (Cecílio et al., 2014) does not prohibit deception, but rather it is a mechanism that is so well employed that it is a typical course of evolution. Deception and mimicry in organisms without complex central nervous systems has been observed for centuries (Kritsky, 2008; Willer, 2009). It is of no debate that other animals deceive, and it is observed with such regularity and commonness in both the laboratory and the natural world that we must concede that deceiving does not require an immense mammalian central nervous system. How is this possible? The answer is simple, as evolutionists even before Darwin had concluded, or at least suspected. Random mutations, or random traits generated via sexual reproduction may be selected for². These mutations, be they a spot of blue in an orchid or a color that camouflages a snake were and are³ initially a random event. The deception does not occur in one generation, but rather gradually over time. The survival of the initial trait may in fact be random initially, such that a fish displaying a sandier color is randomly mated with for reasons that have nothing to do with coloration. However, over time, we might suspect the sandy color fishes living closer to the sea floor have a greater chance of successful reproduction than a sandy colored fish that lives at the surface, therefore making this particular trait non-random.

Because of the randomness of trait variation, a species can bypass a central nervous system or a complicated neural net and survive as a deceiver quite successfully. This being said, there are nuances that help create an understanding and subsequently build a theory.

A brain can assist in mimicry and deception

² Random is a highly debated idea in evolution and is beyond discussion here. Passing on genetic material to the next generation is not based on exclusively random attributes, but the appearance of a mutation or a novel trait through sexual reproduction is often (though not always) random. We wish to emphasize here that random means that there is no planning involved. Simply, markings or pheromones can come to be, to appear in a new generation, or in a new environment, by a random event. Their sustained and long-term prognosis may not be random and in fact must provide some benefit for us to think that it belongs in the category of evolved deception.

³ While potentially obvious to many reading this chapter, we wish to emphasize that evolution is not a long-gone phenomenon of the past, but rather a daily occurrence.

Having a brain can help in the deception of others and oddly enough, a healthy central nervous system allows for the deception of the possessing species, which we often term self-deception (Trivers, 2000; von Hippel & Trivers, 2011). Even though it is not a requirement, evolved neural processes can assist in the production of deception, as well as numerous related processes (e.g., deception detection). In *Homo sapiens*, the CNS works to create deception in ways similar to those of many deceptive animals (e.g., changing our physical appearance to gain access to mates), as well as in novel ways that involve higher-order cognitive abilities possessed only by humans (Keenan, 2002). For example:

A colleague of ours once showed one of us his fake ID. In the United States, the drinking age is 21 and has been for a number of decades. However, the college age of a typical freshman is about 18. Therefore, it is not uncommon for a college student to fake his/her age in order to drink alcohol. My friend had a ploy that involved digging deep into his mammalian central nervous system. He was to use his fake identification to gain access to alcohol. That fake identification was that of his brother. As such he planned his trip to the bar which involved pretending he was his brother. He memorized his brother's birthday, age, weight. He looked up events that his older brother might know that he did not. He found out where his brother drank, and avoided such bars as to not be seen by his brother's friends.

This story is but a brief narrative that we are all familiar with. We tell a lie, act a lie, and become a lie. To tell an effective lie, we often employ many cognitive abilities that are uniquely human to advanced organisms such as Theory of mind.

The ease at which humans deceive is so seamless that we take it for granted. While we should revel in the incredible cognitive gymnastics it takes to lie like a human (Byrne & Corp, 2004), we think of it rarely if ever. In the above 'fake ID' example, our friend is predicting the future, planning contingencies, and altering his own behavior and cognition in the hopes of altering others'. The best of what 'human' minds do, abstract thinking, planning, communication, meta-cognition are all found in this example of a teenager trying to get drunk. Deception is aided by the primate CNS, but to what degree we do not know (Keenan et al., 2005). Teasing out what is only deception is nearly impossible, and it is not known if it is truly possible to do so.

It is not generally thought that this is how moths or protozoa deceive. They don't plot tomorrow's camouflage or wonder if their mothy noises are of a frequency outside of bat hearing. Most researchers think that they just do it (Keenan, 2002), an idea nicely summarized under the construct of anoetic consciousness (Wheeler & Stuss, 2003; Wheeler, Stuss, & Tulving, 1995, 1997). They don't rehearse, or play "If the ant does this, I will do this" games in their minds. Unlike human deception, where we even tell the truth to deceive (i.e., 'bluffing'; Carrión, Keenan, & Sebanz, 2010), it is thought to be unlikely that non-primate organisms play the advanced games we do. And while it is impossible to prove the negative in this case, it is safe to suspect that human deception is entangled with cognitive features (de Waal & Ferrari, 2010) not yet observed in other non-primate animals, and rarely exploited to such an extent in non-human primates (Penn, Holyoak, & Povinelli, 2012; Penn & Povinelli, 2007; Povinelli, 1993; Povinelli & Davis, 1994).

This makes a very simple question nearly impossible to answer. The question, typical in science, is, "Is it a difference of degree or of kind?" In this context we are simply asking if *Homo sapiens* deceive in a manner that is unique, with qualities that are not observed in the comparison group (i.e., all other organisms). While one member of the family of Orchids may differ in coloration in its mimicry from another, that difference is likely to be thought of only as a matter of degree, or in this case frequency. On the other hand, human deception is wholly different than Orchidaceae deception, an analysis that requires but the simplest of examples such as the 'fake I.D.' example previously detailed. Human deception involves the complex cognitive abilities, from language to abstract thinking, which in turn makes the difference one of quality, not quantity. The Orchid mimicking an insect is not the same 'kind' of deception as our friend mimicking his brother. The induced behavior of the deceived may be the same, but for the deceiver, there are immense differences.

When did the first human lie?

Taken from an evolutionary perspective, if X falsely presents information to Y and X's fitness increases, all that matters is that fitness is increased. For the last 3.5 billion years some genetic material persists and some does not. The countless examples of homologous traits and common descendants and shared nodes make many believe that all traits (behaviors and cognitions) are homologous, rather than analogous. This 'tree' thinking pervades the sciences and here we encounter an ultimately difficult case. Because deception has had multiple origins, tracing the evolution of *Homo sapien* deception is very difficult. We have never encountered anyone who believes the protozoa passed the deception gene to the orchid who passed it to the moth and so on until we get to mammals and primates. A serious examination reveals that we don't know when hominid deception started, even within millions of years.

This is highly unfortunate because we suggest that no real understanding of any cognitive function can occur without a better picture of evolution. In terms of deception, we are in fact farther from a clear picture than we were 20 years ago⁴. That is to say, neuroimaging has truly achieved its scientific goal by generating more questions than it has answered. However, neuroscience and neuroimaging are not alone in making the picture difficult to clarify. The expansion of our understanding of the brain-cognition-evolution complication in the last two decades comes from incredible discoveries in physical anthropology, specifically neuroanthropology.⁵ It is here that the confusion expands exponentially. As brains do not preserve, and endocasts are (as of this writing) our best tool in recreating evolved nervous systems, we have relied on a significant paucity of data. Furthermore, since direct behavior does not fossilize, we are again left with no direct evidence. In the last 20 years, we can think of examples that include the discovery of LB1 (*Homo floresiensis*) whose brain is, however you slice it (no pun intended), still challenging our ideas about the timeline of *Homo* brain expansion, the neuro

⁴ Clear does not equal correct. Many of us were taught hypotheses in evolutionary cognitive neuroscience that are no longer thought to be valid such as the direct connection between cortex/brain ratio and tool use.

⁵ For one of the most fascinating discussions about LB1, taking the comic Hobbit tag to the extreme, the esteemed journal *Nature* provides a very interesting discussion (Callaway et al., 2014)

pre-requisites for tool use, what it is about a brain (e.g., frontal gyri formation, overall volume) that allows for higher cognitive abilities (Brown et al., 2004; Falk et al., 2005, 2009; Morwood et al., 2004; Vannucci, Barron, & Holloway, 2013). Within the time of this writing, the major discovery of *Homo naledi* with never before observed features carries drastic implications- from a potential new species to the possibility that our *Homo* ancestors were burying their dead⁶ (Berger et al., 2015; Dirks et al., 2015). In other words, in terms of evolutionary cognitive neuroscience, we can't answer the big questions yet and are still unearthing specimens that cloud rather than clear the goal of pinpointing 'the first *Homo* or *Australopithecus* or primate' that ever told a lie. We don't even know, based on endocasts if early primates were or were not deceiving in the early or pre-Paleogene Period. Our common deceiving grancestor may in fact be a non-primate, but rather a terrestrial mammal. Using fossils we know little.

For example, it has been found that oxytocin facilitates deception in *Homo sapiens*, but amazingly only if the group is benefited. Lies that benefit the individual only are not influenced by oxytocin (Shalvi & De Dreu, 2014). The evolution of oxytocin is such that it has existed for hundreds of million years, much longer than the appearance of the first primate. This leads to the quandary that prairie voles (*Microtus ochrogaster*) who have been examined in infinitum in terms of oxytocin (Carter, Williams, Witt, & Insel, 1992; Johnson et al., 2015; Shen, 2015; Witt, Carter, & Walton, 1990), may have some theory of mind and altruistic behavior components and those behavioral mechanisms are traced not only to oxytocin but to the anterior cingulate gyrus (Burkett et al., 2016). In other words, voles utilize components quite similar to humans, and it is not a reach to think that the critical components to human deception and lying have been in place long before there have been humans.

⁶ Burying the dead is a sign of altruism, and has been used as an indicator that Neanderthal (*Homo sapiens neanderthalensis*) had Theory of Mind abilities, which are highly inter-twined with human deception (Keenan, Rubio, Racioppi, Johnson, & Barnacz, 2005) as both altruism and deception often tap into thinking about the thoughts of others. The idea that we have had altruism 2 million years ago puts forward the possibility that early *Homo* or late *Austral* was capable of deceiving. This is a tenuous notion, but using indications of altruism gives us evidence of Theory of mind which may be evidence that certain organisms had the potential to deceive.

Tracing our evolution through the 'next best' means may be looking at our close ape and non-ape near relatives. Primatologists and Evolutionary Biologists have done much behavioral and neural work to determine human cognitive origins. Deception itself has received little attention, though there are some seminal pieces of research. Byrne and Corp (Byrne & Corp, 2004) used 17 modern primates and discovered a relationship between neocortex and deception-with the conclusion that as neocortex size increases, so do rates of deception. This paper is one of the only systematic approaches that equates deception, cognition, and evolution. From the findings of a number of researchers, we know that our ape relatives can deceive, specifically in *Pan* (Hare, Call, & Tomasello, 2006; Hirata & Matsuzawa, 2001; Osvath & Karvonen, 2012) with numerous experiments and case study observations. However, if one were to categorize the cognitive deceptive abilities in non-human apes, it would be one of skepticism (Call & Tomasello, 1999). Again, given how humans deceive, it is likely a much different way than a chimp does. Unfortunately, we do not know, and thus cannot paint much of an evolutionary picture based on non-human primates. We, however, like Byrne and Corp suspect that even with relatives as close as monkeys and prosimians, deception does not include intention. We do not know (and may never know) if we had deception when we branched off from the monkeys, and then plopped our higher order abilities on top, or if many primates developed deception independently, or both.

Our best chance for tracing the neurological evolution of deception will most likely come from contributions from molecular genetic studies (Pulvermuller, Garagnani, & Wennekers, 2014; Ronan, Wu, & Crabtree, 2013; Shibata, Gulden, & Sestan, 2015). We are far from this, but the idea would be once we have a map of RNA and DNA correlates of human cognition we could tease out what genes evolved and when they emerged. Until that point we must acknowledge that we don't know when, how, or why deception in *Homo* evolved. It is discouraging that major cognitive abilities are not mapped well in terms of evolution (Bolhuis, 2015), for example, something as critical as knowing when humans started

speaking or using theory of mind remain many steps beyond the 'just so story', but we have a long way to go.

To make a final point here, it is almost a certainty that social systems play a role in human deception (DePaulo, Kashy, Kirkendol, Wyer, & Epstein, 1996; Morris et al., 2016; Aldert Vrij, Edward, & Bull, 2001). Many think our complex relationships rely upon deception (DePaulo & Kashy, 1998). However, a species that we know to deceive, the ant, is also a highly social species. It is quite tempting to think humans are just big ants, and over the last 150 million years we have just been perfecting what has already been there. This may be true, but it is very unlikely and the truth is almost certainly more complex. We cannot say that humans gained their "enslaving others" instinct or "pretend to be someone I'm not" instinct from the ants, and that the neurons found in the ants that aid in complex social and deceptive behaviors are the same, homologous, neurons that Homo sapiens use for lying. The social system we employ is different from the very social ant systems, and even though there are commonalities it highly unlikely that human deception has its origins in ant deception.

Humans Lies and Self-deception

From a behavioral point of view, we can be guided by philosophers who have done an excellent job explaining and describing differences between lying and deception, and the extract from this the idea that lying involves activities as 'only humans do'. Being somewhat brief, let us just say that humans lie and deceive, while most other animals just deceive. There is a huge grey area, and many things that humans do to lie (or lie well) are found in other animals, but this point is described above (See Mahon, 2015 for a full discussion).

Most think that intention is critical, and it is the ramping up, planning, sticking to, and intentionally omitting that turns deception into lying. However, as Ganis indicates in his chapter, whichever direction we proceed (i.e., from the brain to behavior, from behavior to the brain, using an

additive or a subtractive process) we have yet to precisely tease out either the brain regions or any other physiological underpinnings that separate deception from anything else in a conclusive manner. Suspect regions such as Brodmann's Areas (BA) 24, 32, 44, 47-48, 9⁷ (Abe, 2009, 2011) still serve other functions which may or may not contribute to deception, and it remains unknown if the brain considers deception a separate, independent process.

Self-deception (see Beyer, this volume), employs similar regions in terms of the brain as the deception of others (Amati, Oh, Kwan, Jordan, & Keenan, 2010; Barrios et al., 2008; Farrow, Burgess, Wilkinson, & Hunter, 2015; Kwan et al., 2007). The area most associated with both intentional and non-intentional self-deception appears to be medial PFC (BA 9/10) as well as lateralized frontal regions including Right mPFC (BA 9, BA8) and Left IPFC. While it is not known if other animals self-deceive, it is certain that self-deception plays a role in human deception. Trivers has argued that one main reason we have seen the evolution of self-deception in *Homo* is that it allows us to be better deceivers of others (Byrne & Kurland, 2001; Trivers, 2000) as well as providing an impetus to face challenges we may otherwise avoid (Lopez & Fuxjager, 2012). Others have noted that self-deception appears to provide a social buffer and that depression may be associated with a lack of self-deception (Gil, 2005). We have added to this theory suggesting a possible additional evolved mechanism by noting that deception detection rates fail to mimic deception rates (Bond & DePaulo, 2006; DePaulo, Zuckerman, & Rosenthal, 1980; Vrij, 1993; Vrij, Mann, Kristen, & Fisher, 2007), which one would imagine would co-evolve at a greater pace. Why is this? One possible answer is that research on detecting deception uses non-natural scenarios and benchmarks that do not make ecological sense (i.e., in the real world we don't just respond he is lying or telling the truth-our real responses need to be much more subtle). A lively debate exists in the literature as to why experimental rates are low, and some have found that when certain

⁷ Brodmann's Areas (BA) are a way to communicate the particular region in the brain. For deception, we see mainly frontal and temporal lobe correlations, though there is also some parietal and motor strip activation during deceptive tasks.

controls are used, lie-detection experts do in fact emerge (Bond, 2008). However, the point remains that deception remains highly effective and often times when people are duped.

Why would we not be better at deception detection? To answer this, we simply suggest this: It is possible that we cognitively lean towards a default state of truth. We assume our own cognitions are truthful, and thus assume what others portray to us are also truthful (Guise et al., 2007). Over a lifetime, this of course changes, and enough dealings with deceptive individuals will change our outlook of others, just like a good psychotherapist can reveal our own self-deception. Yet, we may be born naïve and that naïve stance may serve us well in terms of self-deception, yet poorly in the detection of deception of others. We see this very speculative possibility as one potential line of future research. Even if this hypothesis fails to pan out it is important to acknowledge that self-deception has become a critical component of human existence and it is not by chance that Sigmund Freud based what was to become the most influential theory in psychology on self-deception (Freud, 1938). It is not hyperbolic to suggest that tracing the origins of the brain's self-deception would unlock many mysteries about our existence.

Because we know so little of the evolution of deception and next to nothing of self-deception we are safe in saying that we are in the infancy of research in regards to tracing the evolution of deception and lying. As noted, microcellular techniques are currently promising, but that is not to suggest that out-of-the-ordinary experiments such as those by Libet (Libet, 1995; Libet, 2006; Libet, Wright, & Gleason, 1983); which suggested deception underlies all of our notions of intentionality, won't move the field in novel and fruitful directions. While the present is full of more questions than answers, we can take comfort in the irony that we are likely closer to the truth of deception.

Conclusion

In conclusion, we are far from knowing much about the evolution of deception. Research techniques and technological advances in the last three decades have now matured to the point where we can begin to systematically answer questions such as, “When did humans begin to deceive?” and “What are the necessary and sufficient brain regions involved in self-deception and when did these regions emerge?”. A measured approach from molecular genetics and advanced neuroimaging will aid classic techniques from physical anthropology and psychology in detailing the account of how deception came to be in *Homo sapien*.

References

- Abe, N. (2009). The neurobiology of deception: evidence from neuroimaging and loss-of-function studies. *Current Opinion in Neurology*, 22(6), 594–600.
<http://doi.org/10.1097/WCO.0b013e328332c3cf>
- Abe, N. (2011). How the brain shapes deception: an integrated review of the literature. *The Neuroscientist : A Review Journal Bringing Neurobiology, Neurology and Psychiatry*, 17(5), 560–574. <http://doi.org/10.1177/1073858410393359>
- Adenzato, M., & Ardito, R. (1999). The role of theory of mind and deontic reasoning in the evolution of deception. In *Proceedings of the Twenty-First Conference of the Cognitive Science Society* (pp. 7–12). Lawrence Erlbaum Associates.
- Amati, F., Oh, H., Kwan, V. S. Y., Jordan, K., & Keenan, J. P. (2010). Overclaiming and the medial prefrontal cortex: A transcranial magnetic stimulation study. *Cognitive Neuroscience*, 1(4), 268–276. <http://doi.org/10.1080/17588928.2010.493971>
- Ayasse, M., Stökl, J., & Francke, W. (2011). Chemical ecology and pollinator-driven speciation in sexually deceptive orchids. *Phytochemistry*, 72(13), 1667–1677.
<http://doi.org/10.1016/j.phytochem.2011.03.023>
- Barrios, V., Kwan, V. S. Y., Ganis, G., Gorman, J., Romanowski, J., & Keenan, J. P. (2008). Elucidating the neural correlates of egoistic and moralistic self-enhancement. *Consciousness and Cognition*, 17(2), 451–456. <http://doi.org/10.1016/j.concog.2008.03.006>
- Berger, L. R., Hawks, J., de Ruiter, D. J., Churchill, S. E., Schmid, P., Deleuzene, L. K., ... Zipfel, B. (2015). *Homo naledi*, a new species of the genus *Homo* from the Dinaledi Chamber, South Africa. *eLife*, 4. <http://doi.org/10.7554/eLife.09560>

- Bolhuis, J. J. (2015). Evolution cannot explain how minds work. *Behavioural Processes*, 117, 82–91.
<http://doi.org/10.1016/j.beproc.2015.06.008>
- Bond, C. F. J., & DePaulo, B. M. (2006). Accuracy of deception judgments. *Personality and Social Psychology Review : An Official Journal of the Society for Personality and Social Psychology, Inc*, 10(3), 214–234. http://doi.org/10.1207/s15327957pspr1003_2
- Bond, G. (2008). Deception detection expertise. *Law and Human Behavior*, 32(4), 339–51.
- Brown, P., Sutikna, T., Morwood, M. J., Soejono, R. P., Jatmiko, Saptomo, E. W., & Due, R. A. (2004). A new small-bodied hominin from the Late Pleistocene of Flores, Indonesia. *Nature*, 431(7012), 1055–1061. <http://doi.org/10.1038/nature02999>
- Burkett, J. P., Andari, E., Johnson, Z. V., Curry, D. C., de Waal, F. B. M., & Young, L. J. (2016). Oxytocin-dependent consolation behavior in rodents. *Science (New York, N.Y.)*, 351(6271), 375–378.
<http://doi.org/10.1126/science.aac4785>
- Byrne, C. C., & Kurland, J. A. (2001). Self-deception in an evolutionary game. *Journal of Theoretical Biology*, 212(4), 457–480. <http://doi.org/10.1006/jtbi.2001.2390>
- Byrne, C., & Kurland, J. (2001). Self-deception in an evolutionary game. *Journal of Theoretical Biology*, 212(4), 457–480. <http://doi.org/10.1006/jtbi.2001.2390>
- Byrne, R., & Corp, N. (2004). Neocortex size predicts deception rate in primates. *Proceedings. Biological Sciences / The Royal Society*, 271(1549), 1693–1699. <http://doi.org/10.1098/rspb.2004.2780>
- Byrne, R. W., & Corp, N. (2004). Neocortex size predicts deception rate in primates. *Proceedings. Biological Sciences / The Royal Society*, 271(1549), 1693–1699.
<http://doi.org/10.1098/rspb.2004.2780>
- Callaway, E., Sutikna, T., Roberts, R., Saptomo, W., Brown, P., Gee, H., ... Aiello, L. (2014). The discovery of Homo floresiensis: Tales of the hobbit. *Nature*, 514(7523), 422–426.
<http://doi.org/10.1038/514422a>

- Call, J., & Tomasello, M. (1999). A nonverbal false belief task: the performance of children and great apes. *Child Development, 70*(2), 381–395.
- Carrión, R. E., Keenan, J. P., & Sebanz, N. (2010). A truth that's told with bad intent: an ERP study of deception. *Cognition, 114*(1), 105–110. <http://doi.org/10.1016/j.cognition.2009.05.014>
- Carter, C. S., Williams, J. R., Witt, D. M., & Insel, T. R. (1992). Oxytocin and social bonding. *Annals of the New York Academy of Sciences, 652*, 204–211.
- Cecílio, P., Pérez-Cabezas, B., Santarém, N., Maciel, J., Rodrigues, V., & Cordeiro da Silva, A. (2014). Deception and manipulation: the arms of leishmania, a successful parasite. *Frontiers in Immunology, 5*, 480. <http://doi.org/10.3389/fimmu.2014.00480>
- Cheney, K. L., & Côté, I. M. (2005). Frequency-dependent success of aggressive mimics in a cleaning symbiosis. *Proceedings. Biological Sciences / The Royal Society, 272*(1581), 2635–2639. <http://doi.org/10.1098/rspb.2005.3256>
- DePaulo, B. M., & Kashy, D. A. (1998). Everyday lies in close and casual relationships. *Journal of Personality and Social Psychology, 74*(1), 63–79.
- DePaulo, B. M., Kashy, D. A., Kirkendol, S. E., Wyer, M. M., & Epstein, J. A. (1996). Lying in everyday life. *Journal of Personality and Social Psychology, 70*(5), 979–995.
- DePaulo, B. M., Zuckerman, M., & Rosenthal, R. (1980). Humans as lie detectors. *The Journal of Communication, 30*(2), 129–139.
- de Waal, F. B. M., & Ferrari, P. F. (2010). Towards a bottom-up perspective on animal and human cognition. *Trends in Cognitive Sciences, 14*(5), 201–207. <http://doi.org/10.1016/j.tics.2010.03.003>
- Dirks, P. H. G. M., Berger, L. R., Roberts, E. M., Kramers, J. D., Hawks, J., Randolph-Quinney, P. S., ... Tucker, S. (2015). Geological and taphonomic context for the new hominin species *Homo naledi* from the Dinaledi Chamber, South Africa. *eLife, 4*. <http://doi.org/10.7554/eLife.09561>

- Falk, D., Hildebolt, C., Smith, K., Morwood, M. J., Sutikna, T., Brown, P., ... Prior. (2005). The brain of LB1, *Homo floresiensis*. *Science (New York, N.Y.)*, *308*(5719), 242–245.
<http://doi.org/10.1126/science.1109727>
- Falk, D., Hildebolt, C., Smith, K., Morwood, M. J., Sutikna, T., Jatmiko, ... Prior, F. (2009). LB1's virtual endocast, microcephaly, and hominin brain evolution. *Journal of Human Evolution*, *57*(5), 597–607. <http://doi.org/10.1016/j.jhevol.2008.10.008>
- Farrow, T. F. D., Burgess, J., Wilkinson, I. D., & Hunter, M. D. (2015). Neural correlates of self-deception and impression-management. *Neuropsychologia*, *67*, 159–174.
<http://doi.org/10.1016/j.neuropsychologia.2014.12.016>
- Freud, S. (1938). *The Basic Writings of Sigmund Freud* (Modern Library Edition). New York, NY: Random House.
- Ganis, G., Kosslyn, S. M., Stose, S., Thompson, W. L., & Yurgelun-Todd, D. A. (2003). Neural correlates of different types of deception: an fMRI investigation. *Cerebral Cortex (New York, N.Y.: 1991)*, *13*(8), 830–836.
- Ganis, G., Morris, R. R., & Kosslyn, S. M. (2009). Neural processes underlying self- and other-related lies: an individual difference approach using fMRI. *Social Neuroscience*, *4*(6), 539–553.
<http://doi.org/10.1080/17470910801928271>
- Ganis, G., & Patnaik, P. (2009). Detecting concealed knowledge using a novel attentional blink paradigm. *Applied Psychophysiology and Biofeedback*, *34*(3), 189–196. <http://doi.org/10.1007/s10484-009-9094-1>
- Ganis, G., Rosenfeld, J. P., Meixner, J., Kievit, R. A., & Schendan, H. E. (2011). Lying in the scanner: covert countermeasures disrupt deception detection by functional magnetic resonance imaging. *NeuroImage*, *55*(1), 312–319. <http://doi.org/10.1016/j.neuroimage.2010.11.025>

- Gaskett, A. C. (2011). Orchid pollination by sexual deception: pollinator perspectives. *Biological Reviews of the Cambridge Philosophical Society*, *86*(1), 33–75. <http://doi.org/10.1111/j.1469-185X.2010.00134.x>
- Gil, A. (2005). Repressing distress in childhood: a defense against health-related stress. *Child Psychiatry and Human Development*, *36*(1), 27–52. <http://doi.org/10.1007/s10578-004-3605-3>
- Guise, K., Kelly, K., Romanowski, J., Vogeley, K., Platek, S. M., Murray, E., & Keenan, J. P. (2007). The Anatomical and Evolutionary Relationship between Self-awareness and Theory of Mind. *Human Nature (Hawthorne, N.Y.)*, *18*(2), 132–142. <http://doi.org/10.1007/s12110-007-9009-x>
- Hare, B., Call, J., & Tomasello, M. (2006). Chimpanzees deceive a human competitor by hiding. *Cognition*, *101*(3), 495–514. <http://doi.org/10.1016/j.cognition.2005.01.011>
- Hirata, S., & Matsuzawa, T. (2001). Tactics to obtain a hidden food item in chimpanzee pairs (*Pan troglodytes*). *Animal Cognition*, *4*(3-4), 285–295. <http://doi.org/10.1007/s100710100096>
- Jersáková, J., Johnson, S. D., & Kindlmann, P. (2006). Mechanisms and evolution of deceptive pollination in orchids. *Biological Reviews of the Cambridge Philosophical Society*, *81*(2), 219–235. <http://doi.org/10.1017/S1464793105006986>
- Johnson, Z. V., Walum, H., Jamal, Y. A., Xiao, Y., Keebaugh, A. C., Inoue, K., & Young, L. J. (2015). Central oxytocin receptors mediate mating-induced partner preferences and enhance correlated activation across forebrain nuclei in male prairie voles. *Hormones and Behavior*, *79*, 8–17. <http://doi.org/10.1016/j.yhbeh.2015.11.011>
- Keenan, J. P. (2002). *The Face in the Mirror*. New York, NY: Harper Collins: Ecco.
- Keenan, J. P., Rubio, J., Racioppi, C., Johnson, A., & Barnacz, A. (2005). The right hemisphere and the dark side of consciousness. *Cortex; a Journal Devoted to the Study of the Nervous System and Behavior*, *41*(5), 695–704; discussion 731–734.

- Kitamura, T., & Imafuku, M. (2015). Behavioural mimicry in flight path of Batesian intraspecific polymorphic butterfly *Papilio polytes*. *Proceedings. Biological Sciences / The Royal Society*, 282(1809), 20150483. <http://doi.org/10.1098/rspb.2015.0483>
- Kritsky, G. (2008). Entomological reactions to Darwin's theory in the nineteenth century. *Annual Review of Entomology*, 53, 345–360. <http://doi.org/10.1146/annurev.ento.53.103106.093436>
- Kwan, V. S. Y., Barrios, V., Ganis, G., Gorman, J., Lange, C., Kumar, M., ... Keenan, J. P. (2007). Assessing the neural correlates of self-enhancement bias: a transcranial magnetic stimulation study. *Experimental Brain Research*, 182(3), 379–385. <http://doi.org/10.1007/s00221-007-0992-2>
- Leal, S., Vrij, A., Fisher, R. P., & van Hooff, H. (2008). The time of the crime: cognitively induced tonic arousal suppression when lying in a free recall context. *Acta Psychologica*, 129(1), 1–7. <http://doi.org/10.1016/j.actpsy.2008.03.015>
- Libet, B. (1995). Necessary brain. *Nature*, 375(6527), 100. <http://doi.org/10.1038/375100d0>
- Libet, B. (2006). Reflections on the interaction of the mind and brain. *Progress in Neurobiology*, 78(3-5), 322–326. <http://doi.org/10.1016/j.pneurobio.2006.02.003>
- Libet, B., Wright, E. W. J., & Gleason, C. A. (1983). Preparation- or intention-to-act, in relation to pre-event potentials recorded at the vertex. *Electroencephalography and Clinical Neurophysiology*, 56(4), 367–372.
- Lopez, J. K., & Fuxjager, M. J. (2012). Self-deception's adaptive value: effects of positive thinking and the winner effect. *Consciousness and Cognition*, 21(1), 315–324. <http://doi.org/10.1016/j.concog.2011.10.008>
- Mahon, J. (2015). The definition of lying and deception. In *The Stanford Encyclopedia of Philosophy*. Retrieved from <http://plato.stanford.edu/entries/lying-definition/>

- Malcicka, M., Bezemer, T. M., Visser, B., Bloemberg, M., Snart, C. J. P., Hardy, I. C. W., & Harvey, J. A. (2015). Multi-trait mimicry of ants by a parasitoid wasp. *Scientific Reports*, 5, 8043. <http://doi.org/10.1038/srep08043>
- Morris, W. L., Sternglanz, R. W., Ansfield, M. E., Anderson, D. E., Snyder, J. L. H., & DePaulo, B. M. (2016). A Longitudinal Study of the Development of Emotional Deception Detection Within New Same-Sex Friendships. *Personality & Social Psychology Bulletin*, 42(2), 204–218. <http://doi.org/10.1177/0146167215619876>
- Morwood, M. J., Soejono, R. P., Roberts, R. G., Sutikna, T., Turney, C. S. M., Westaway, K. E., ... Fifield, L. K. (2004). Archaeology and age of a new hominin from Flores in eastern Indonesia. *Nature*, 431(7012), 1087–1091. <http://doi.org/10.1038/nature02956>
- Osvath, M., & Karvonen, E. (2012). Spontaneous innovation for future deception in a male chimpanzee. *PloS One*, 7(5), e36782. <http://doi.org/10.1371/journal.pone.0036782>
- Penn, D. C., Holyoak, K. J., & Povinelli, D. J. (2012). So, are we the massively lucky species? *The Behavioral and Brain Sciences*, 35(4), 236–237. <http://doi.org/10.1017/S0140525X11002159>
- Penn, D. C., & Povinelli, D. J. (2007). On the lack of evidence that non-human animals possess anything remotely resembling a “theory of mind”. *Philosophical Transactions of the Royal Society of London. Series B, Biological Sciences*, 362(1480), 731–744. <http://doi.org/10.1098/rstb.2006.2023>
- Pfennig, D. W., & Mullen, S. P. (2010). Mimics without models: causes and consequences of allopatry in Batesian mimicry complexes. *Proceedings. Biological Sciences / The Royal Society*, 277(1694), 2577–2585. <http://doi.org/10.1098/rspb.2010.0586>
- Povinelli, D. J. (1993). Reconstructing the evolution of mind. *The American Psychologist*, 48(5), 493–509.

- Povinelli, D. J., & Davis, D. R. (1994). Differences between chimpanzees (*Pan troglodytes*) and humans (*Homo sapiens*) in the resting state of the index finger: implications for pointing. *Journal of Comparative Psychology (Washington, D.C. : 1983)*, *108*(2), 134–139.
- Powell, S., Del-Claro, K., Feitosa, R. M., & Brandão, C. R. F. (2014a). Mimicry and eavesdropping enable a new form of social parasitism in ants. *The American Naturalist*, *184*(4), 500–509.
<http://doi.org/10.1086/677927>
- Powell, S., Del-Claro, K., Feitosa, R. M., & Brandão, C. R. F. (2014b). Mimicry and eavesdropping enable a new form of social parasitism in ants. *The American Naturalist*, *184*(4), 500–509.
<http://doi.org/10.1086/677927>
- Pulvermuller, F., Garagnani, M., & Wennekers, T. (2014). Thinking in circuits: toward neurobiological explanation in cognitive neuroscience. *Biological Cybernetics*, *108*(5), 573–593.
<http://doi.org/10.1007/s00422-014-0603-9>
- Ronan, J. L., Wu, W., & Crabtree, G. R. (2013). From neural development to cognition: unexpected roles for chromatin. *Nature Reviews. Genetics*, *14*(5), 347–359. <http://doi.org/10.1038/nrg3413>
- Schiestl, F. P. (2005). On the success of a swindle: pollination by deception in orchids. *Die Naturwissenschaften*, *92*(6), 255–264. <http://doi.org/10.1007/s00114-005-0636-y>
- Shalvi, S., & De Dreu, C. K. W. (2014). Oxytocin promotes group-serving dishonesty. *Proceedings of the National Academy of Sciences of the United States of America*, *111*(15), 5503–5507.
<http://doi.org/10.1073/pnas.1400724111>
- Shen, H. (2015). Neuroscience: The hard science of oxytocin. *Nature*, *522*(7557), 410–412.
<http://doi.org/10.1038/522410a>
- Shibata, M., Gulden, F. O., & Sestan, N. (2015). From trans to cis: transcriptional regulatory networks in neocortical development. *Trends in Genetics : TIG*, *31*(2), 77–87.
<http://doi.org/10.1016/j.tig.2014.12.004>

- Trivers, R. (2000). The elements of a scientific theory of self-deception. *Annals of the New York Academy of Sciences*, 907, 114–131.
- Uma, D., Durkee, C., Herzner, G., & Weiss, M. (2013). Double deception: ant-mimicking spiders elude both visually- and chemically-oriented predators. *PLoS One*, 8(11), e79660.
<http://doi.org/10.1371/journal.pone.0079660>
- Vannucci, R. C., Barron, T. F., & Holloway, R. L. (2013). Frontal brain expansion during development using MRI and endocasts: relation to microcephaly and *Homo floresiensis*. *Anatomical Record (Hoboken, N.J. : 2007)*, 296(4), 630–637. <http://doi.org/10.1002/ar.22663>
- von Hippel, W., & Trivers, R. (2011). The evolution and psychology of self-deception. *The Behavioral and Brain Sciences*, 34(1), 1–16; discussion 16–56. <http://doi.org/10.1017/S0140525X10001354>
- Vrij, A. (1993). Credibility judgements of detectives: the impact of nonverbal behavior, social skills, and physical characteristics on impression formation. *The Journal of Social Psychology*, 133(5), 601–610. <http://doi.org/10.1080/00224545.1993.9713915>
- Vrij, A., Edward, K., & Bull, R. (2001). People's insight into their own behaviour and speech content while lying. *British Journal of Psychology (London, England : 1953)*, 92 Part 2, 373–389.
- Vrij, A., Mann, S. A., Fisher, R. P., Leal, S., Milne, R., & Bull, R. (2008). Increasing cognitive load to facilitate lie detection: the benefit of recalling an event in reverse order. *Law and Human Behavior*, 32(3), 253–265. <http://doi.org/10.1007/s10979-007-9103-y>
- Vrij, A., Mann, S., Kristen, S., & Fisher, R. P. (2007). Cues to deception and ability to detect lies as a function of police interview styles. *Law and Human Behavior*, 31(5), 499–518.
<http://doi.org/10.1007/s10979-006-9066-4>
- Waterman, R. J., & Bidartondo, M. I. (2008). Deception above, deception below: linking pollination and mycorrhizal biology of orchids. *Journal of Experimental Botany*, 59(5), 1085–1096.
<http://doi.org/10.1093/jxb/erm366>

- Wheeler, M. A., & Stuss, D. T. (2003). Remembering and knowing in patients with frontal lobe injuries. *Cortex; a Journal Devoted to the Study of the Nervous System and Behavior*, 39(4-5), 827–846.
- Wheeler, M. A., Stuss, D. T., & Tulving, E. (1995). Frontal lobe damage produces episodic memory impairment. *Journal of the International Neuropsychological Society : JINS*, 1(6), 525–536.
- Wheeler, M. A., Stuss, D. T., & Tulving, E. (1997). Toward a theory of episodic memory: the frontal lobes and autonoetic consciousness. *Psychological Bulletin*, 121(3), 331–354.
- Willer, S. (2009). “Imitation of similar beings”: social mimesis as an argument in evolutionary theory around 1900. *History and Philosophy of the Life Sciences*, 31(2), 201–213.
- Witt, D. M., Carter, C. S., & Walton, D. M. (1990). Central and peripheral effects of oxytocin administration in prairie voles (*Microtus ochrogaster*). *Pharmacology, Biochemistry, and Behavior*, 37(1), 63–69.
- Wyatt, T. D. (2014). Introduction to Chemical Signaling in Vertebrates and Invertebrates. In C. Mucignat-Caretta (Ed.), *Neurobiology of Chemical Communication*. Boca Raton (FL): CRC Press. Retrieved from <http://www.ncbi.nlm.nih.gov/books/NBK200995/>