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# **Yawn, Yawn, Yawn, Yawn; Yawn, Yawn, Yawn! The Social, Evolutionary and Neuroscientific Facets of Contagious Yawning**

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## **Abstract**

Contagious yawning is a common phenomenon affecting upwards of 60% of healthy humans. It has also been observed, at a lesser rate, in great apes and other primates. Here I summarize the suggestion that contagious yawning is a primitive expression of social cognition, namely empathy. Susceptibility to contagious yawning is correlated with the speed in recognizing one's own face, theory of mind processing, and is also associated with activation in regions of the brain that have been associated with social cognitive processes. This suggests that contagious yawning may be an evolutionarily old process that begot a higher level of social cognition in certain species. Copyright © 2010 S. Karger AG, Basel

Did you just yawn? The title of this chapter was designed in such a way as to evoke a common human behavioral response, i.e. to yawn contagiously. If you did yawn, you are among 60% of other humans that also respond contagiously to hearing, seeing, observing and even reading about yawning [1–3].

While contagious yawning is a common experience among people, yawning actually remains one of the great understudied phenomena of science. You might mistakenly believe that we yawn to reset the balance of blood oxygenation; however, this is not actually the case. It turns out that yawning may serve a more adaptive function: cooling the brain [4–6]. The function of yawning is not, however, the focus of this chapter. Here I will discuss the current evidence that contagious yawning is a byproduct of evolutionarily designed programs related to empathy, social cognition and/or self-awareness.

## **Relationship between Self-Awareness and Other Awareness**

In 1970, Gallup [7] discovered that chimpanzees possess the ability to recognize themselves in a mirror [see also: 8–15]. He suggested that the now infamous mirror

test was a marker for the presence of a sense of self-awareness. Furthermore, combining his findings with evidence that was emerging from cognitive primatology, he hypothesized that the ability to generalize about mental states – mental state attribution – presupposed a sense of self-awareness. He theorized that the presence of self-awareness paved the way for a cognitive substrate for mental state attribution, or theory of mind. The possession of a theory of mind lends to it the ability to empathize, sympathize, relate emotionally to another individual, anthropomorphize, and generally experience the world through another person's perspective. Interestingly, many of us do not have to 'think' about theory of mind, i.e. for most healthy humans the ability to think about another person's mental state is automatic.

In this respect, when we observe another person experiencing something, we have an inherent experience that is similar to that person. However, in most cases we do not automatically emulate that person's experience. Let me provide an example. If I were to walk across the stage in the front of one of my classrooms and trip over an electric wire that was laying in my way. The audience would be in a position to empathize with my position and experience. They might, admittedly, find humor in my ostensibly embarrassing behavior. And that would be an appropriate mental state attribution. They would be utilizing their experience with non-fatal falls which is highly correlated with a feeling or cognitive experience of embarrassment. However, if after a few seconds of laughing they discovered that upon tripping over the cable I had landed face down on the stage and there was a pool of red liquid forming quickly around my head, (I hope) their chuckles would turn to worry. They would be able to see that my fall was much more serious than they had originally conceptualized. They would not have to 'think' actively about this change in cognition, rather because our brains are hard-wired for sociality there is little actual thinking necessary for this process to take place. In the previous example, onlookers would have to be able to rapidly change inference about my mental state to make an adaptive response (albeit in my favor) to call for emergency help. They would not need to cognate about the decision: 'He seems to have tripped. That was funny in my past, and so it must be funny now. Oh wait, he's fallen on his face and is bleeding. I need a new cognition for that ...' If our empathic understanding of others' mental states were to flow in this fashion, we would all be pretty socially awkward!

All that being said, in neither of these cases would the audience's empathic mental state attribution result in an actual replication of my experience in an observer. The audience would not spontaneously feel embarrassed and then upon falling on my face get sudden feeling of panic and pain and fear! Their feelings are attributions, good guesses, hypotheses about how I might be feeling or what my experience is like. In certain cases, the attribution produces a contagion. This typically occurs in the context of a personal emotional experience such as someone crying. If your sister, mother, child or even close friend came to your house and started to

cry and express extreme sadness you might be compelled, somewhat uncontrollably, to begin crying yourself. Your empathic understanding of her mental state has manifested itself in your own outward expression. Similar examples exist in the realm of happiness; in fact, laughter is quite contagious. Coughing may also be contagious. Even these attributions turned experiences are somewhat controllable. When your child comes running into your arms crying one can, if they try hard enough, usually quell the crying response. In the case of contagious yawning, however, once the onset of a yawn begins it is virtually impossible to quell the execution of the yawn.

The evidence for the relationship between self-processing and mental state attribution comes from comparative primatology, developmental psychology, cognitive psychology and cognitive neuroscience. I have briefly summarized the major findings here. First, since the discovery that chimpanzees could recognize themselves in a mirror, there have been numerous studies aimed at testing whether chimpanzees (and other great apes) have the capacity for a theory of mind [8, 14, 16]. Similarly, correlate tasks have been made on other species including but not limited to corvids, elephants, cetaceans, and lesser primates. In fact, it seems like only those species that reliably demonstrate a sense of self-awareness also show a corresponding capacity for other-awareness.

Developmental psychology represents another example of this. Children tend to develop a sense of self at about 15 months of age [8]. During this time, they begin to use personal pronouns and referential pointing. It is also during this time that children show the ability to recognize themselves in a mirror. Amsterdam [17] first tested this by converting the mark test, used in non-human primates, into the rouge test. It is important to note that shortly after the emergence of self-awareness, or more specifically mirror self-recognition, children begin to develop theory of mind. That is, shortly after 15–24 months of age – when children show mirror self-recognition – they begin to develop a set of cognitions based on desire, belief and social relationships.

When it comes to adult cognition, a similar relationship exists. Keenan et al. [18–23] were the first to test for reaction time differences in self-face recognition. He and his team showed that people were significantly faster at differentiating self-faces from other faces when using their left-hand. This he interpreted as an indication for a right hemisphere bias for self-processing. As a follow-up to Keenan's studies, Platek et al. [24, 25] replicated the left-hand/right hemisphere bias for self-processing and also showed that reaction times to self-face correlated with performance on higher level theory of mind tasks. In an fMRI study, Platek et al. [26] showed that the same regions of the right frontal lobe were recruited when participants were asked to recognize their own face and when they were asked to solve a theory of mind task. Several other studies have now also supported the link between self-processing and theory of mind by using a plethora of methodological techniques, including reaction times and functional neuroimaging.

## Contagious Yawning in the Self-Other Relationship

Because contagious yawning produces an unconsciously controlled automatic release of a contagious yawn in an observer – several researchers, e.g. Platek et al. [2, 3] have hypothesized that contagious yawning might be an evolutionary predecessor to a more sophisticated sense of empathy/mental state attribution. In order to test this, Platek et al. [2] investigated whether there was a relationship between speed in identifying one's own face, performance on a set of theory of mind stories, and susceptibility to contagious yawning. They showed that people who were better at solving higher order theory of mind (faux pas) tasks were more susceptible to contagious yawning. They interpreted these findings as showing a link between the automatic empathic processing associated with contagious yawning and other theory of mind processes. Taken together with the finding that theory of mind and self-processing share neural architecture, this indicates that self-processing, theory of mind and contagious yawning might share similar substrates as well as similar processing.

### Evidence from Neuroimaging

There are now a handful of studies incorporating functional neuroimaging to investigate the neural substrates associated with contagious yawning. The first of these was by Platek et al. [3]. They showed activation in posterior midline substrates – the precuneus and posterior cingulate. Schurmann et al. [27] conducted a similar study and demonstrated activation in the superior temporal sulcus and more general activation across a mirror neuron system. Two studies [28, 29] found activation in frontal lobe circuitry. While Platek et al. [3] argued that activation of the posterior cingulate/precuneous was associated with autobiographical memories and self-processing, this finding might appear to be difficult to rectify in the presence of such disparate findings from other laboratories. However, if we inspect each of the findings from the various fMRI studies of contagious yawning, a commonality exists: each study shows activation in cortical association areas that have been indirectly linked to theory of mind and/or self-processing. Thus, if one takes these early and inconclusive findings from functional neuroimaging in conjunction with the cognitive and behavioral expressions of contagious yawning within and between species, the argument for contagious yawning being a product of primitive/vestigial empathic drives stands firm.

### Conclusions

The expression of contagious yawning appears to be relatively robust in man and partially present in lesser primates. Contagious yawning appears to exist in species that

also show a capacity for self-processing and theory of mind, albeit rudimentary in some cases. Recent neuroimaging evidence suggests that there could be multiple brain loci involved in the contagious yawning response; however, it's important to note that each fMRI study has identified activation in brain substrates that have been implicated in social cognition, self-processing and/or theory of mind in other studies. Thus, it is our contention that contagious yawning is a vestigial fixed action pattern that may be a glimpse into the neurobiological substrates that gave rise to more sophisticated social cognitive processes such as theory of mind.

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