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Contagious Yawning: Developmental and Comparative Perspectives

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Abstract

Contagious yawning (i.e., yawning triggered by perceiving others' yawning) is a well-documented phenomenon, but the mechanism underlying it is still unclear. In this chapter, I review the current evidence about (a) developmental studies with typically and atypically developing population and (b) comparative studies in non-human animals. Developmental studies have revealed that contagious yawning is disturbed in individuals with Autism Spectrum Disorders, suggesting that contagious yawning may share a developmental basis with the capacity for theory of mind. Comparative studies have suggested that contagious yawning can be observed in non-primate species such as domestic dogs. As dogs are known to have exceptional skills in communicating with humans, it has also been suggested that contagious yawning may be related to the capacity for social communication. These results from developmental and comparative studies are consistent with the claim that the mechanism underlying contagious yawning relates to the capacity for empathy.

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Introduction

Contagious yawning (i.e., yawning triggered by perceiving others' yawning) is a well-documented phenomenon. Previous studies have consistently reported that, in a naturalistic or controlled experimental context, 45-60 % of human adults yawn when they observe, hear or imagine others' yawning [1]. It is not due to common environmental factors between two yawners such as temperature, lighting or the lack of oxygen, because pre-recorded yawning video clips and sounds can also induce contagious yawning [2-4]. Recently, this phenomenon has been widely sought after in the field of developmental and comparative cognitive sciences. Apart from the intrinsic interest in this well-known but puzzling phenomenon, this is mainly because it is apparently empathetic: the observation of the emotional or physiological status of

other individuals affects the emotional or physiological status of observer in a corresponding manner. Some researchers claim that the presence of contagious yawning in non-human animals is an index for the capacity for empathy [5, 6] and absence of contagious yawning in a developmental disorder or a psychiatric condition suggests a disturbance in the capacity for empathy [7, 8].

In this chapter, I review the current evidence from (a) developmental studies with typically and atypically developing population and (b) comparative studies in non-human animals, discuss its implications for the mechanism underlying contagious yawning, and raise several issues for future studies.

Typical and atypical development of contagious yawning

Apart from the initial case study by Piaget [9], who based on the observation of his own daughter reported that yawning in response to seeing a yawn started at the second year of life, Anderson and Meno [2] are the first and the only to report a developmental trajectory of contagious yawning from an elaborate cross-sectional study. In their study, typically developing children aged 2 to 11 years old were exposed to a video presentation of yawning adults and a story including a yawning protagonist. The results revealed that some of the children aged 5 years or older showed contagious yawning in response to the video stimuli, and some of the children aged 6 years or older showed yawning in response to the yawning story. These results failed to replicate this early observation by Piaget [9], but the negative results reported for preschoolers should be treated with caution. For example, Anderson and Meno [2] discussed the possibility that familiarity with yawning adults may be relevant to the differences between these two studies.

In addition to the investigation of typical development, other scientists, including our group, have investigated the development of contagious yawning in children with autism spectrum disorders (ASD), who show atypical development in social interaction and communication [10]. Firstly, our research group has presented videotaped yawning as well as control mouth-opening action to children with ASD as well as typically developing children between the age of 7 and 15 years old [8]. Typically developing children showed more yawning in response to yawning movies than to control movies. By contrast, children with ASD showed equally frequent yawning in response to both yawning and control movies (Figure 1). These results replicated Anderson and Meno [2] in that typically developing children at the age of 7 years or older show contagious yawning. More importantly, this was the first study to demonstrate the absence of contagious yawning in children with ASD. Secondly, Giganti and Esposito Ziello [11] further explored the level of intellectual development on the tendency to yawn contagion in children with ASD, by comparing children with ASD with higher and lower intellectual ability between the age of 11 and 15 years old. They also used the auditory stimuli of yawning sounds, in addition to the visual stimuli of yawning face, and also have the frequency of spontaneous yawning recorded by the parents. The results replicated that both visual and auditory yawning stimuli elicited more yawning in typically developing children than in children with ASD. They did not find any effect of intellectual ability or group differences in the frequency of spontaneous yawning. These two studies suggest that children with ASD have an

impairment in the mechanism relevant to the capacity for contagious yawning.

Thirdly, a recent study by the author's group [12] used a similar task used in Senju et al. [8] with an additional instruction to fixate on the eyes of yawning face. The aim of this study was to test a hypothesis that an absence of contagious yawning in ASD is related to atypical social orienting, particularly the reduced spontaneous fixation on the eyes [13], because it has been reported that yawning eyes are as potent stimuli in eliciting yawning as the whole face, but a yawning mouth alone is not [14]. The results revealed that children with ASD yawned equally frequently in response to yawning stimuli as typically developing children once the additional instruction to fixate on the eyes was added. This is consistent with the hypothesis that reduced spontaneous fixations on the eyes may contribute to the absence of contagious yawning in ASD.

This research is consistent with the claim that the mechanism underlying contagious yawning relates to the capacity for theory of mind [4], the impairment of which is widely and consistently reported in individuals with ASD [15, 16]. However, the preliminary results of Senju et al. [12] may suggest that the absence of contagious yawning in ASD is mediated by the atypical pattern of spontaneous orienting to the eyes [13], not by the impairment in theory of mind *per se*. It is also possible that atypical social orienting is the common developmental basis of both atypical contagious yawning and the difficulty in theory of mind [17]. Further studies will be required to test the early development of contagious yawning in ASD, and its relation to the development of the social brain network.

Contagious yawning in non-human animals

To the best of my knowledge, Anderson et al. [5] is the first to report quantitative data on contagious yawning in non-human animals. They presented yawning and control movies to three adult and three young chimpanzees (*Pan troglodytes*), and found a significant increase in the frequency of yawning in response to yawning movies in two adult chimpanzees. This result was replicated by a larger follow-up study [18]. In addition, Paukner and Anderson [19] reported that yawning movies elicit more yawning than control movies in stumptail macaques (*Macaca arctoides*). These studies suggest that the susceptibility to contagious yawning is not specific to humans, but could be shared with other non-human primate species.

A further question arises as to whether contagious yawning emerged during primate evolution, or is shared with an even wider range of animal species. To tackle this question, our research group conducted an experimental study to test whether domestic dogs (*Canis familiaris*) also show contagious yawning [6]. This study has been motivated by several anecdotes from colleagues and other dog-owners that their yawns elicit yawns from their dogs. Similar anecdotes can also be found in literature [20, 21]. In our study, 29 dogs observed live presentation of acted yawns by an experimenter, as well as the same human experimenter's non-yawning mouth movement. The experimenter called the dogs and/or presented a small bait in front of the experimenter's face to make sure that the dogs made clear eye contact with the experimenter just before the experimenter presented a yawning or control mouth movement. Testing was conducted in places familiar to each dog, between 11 am and 4 pm and after they had finished walking and had one of their two daily meals, to make sure that dogs attended

the experiments in the least stressful way. 21 out of 29 dogs yawned in response to the experimenter's yawns (Figure 2), but no dogs showed yawning in response to the control mouth movement produced by the same experimenter. These results clearly suggest that human yawns elicit a yawning response in dogs. Following our study, Harr et al. {Harr, #1375} presented video clips of humans and dogs yawning, as well as non-yawning mouth opening actions, to 15 dogs. Only one dog exhibited significantly more yawns in response to yawning video clips than to control video clips. It is not clear why Harr et al. {Harr, #1375} failed to replicate Joly-Mascheroni et al. [6], but it is likely that the way stimuli were presented contributed to the apparent discrepancy: it is possible that either the live presentation of stimuli, the social interaction between the yawning person and the dog and/or establishment of eye contact before stimulus presentation is important for eliciting contagious yawning in dogs.

These results clearly demonstrated that human yawns elicit yawning in dogs, supporting the claim that the capacity for contagious yawning can be shared beyond the primate species. However, it is not necessarily warranted that the mechanism underlying contagious yawning is also shared among these species. For example, Paukner and Anderson [19] raised the possibility that apparent contagious yawning in stumptail macaques may be based on the heightened tension or stress induced by the observation of yawning, as yawning is a threatening signal in this species. Similarly, one could claim that part of the yawns observed in Joly-Mascheroni et al. [6] was a stress-related response induced by the yawning of a stranger, as some have argued that yawning in dogs is a response to acute stress [23]. However, more recent empirical studies [24, 25] have failed to confirm the relationship between stress and yawning, making this claim less convincing. Moreover, the presence of contagious yawning even when the potential "tension yawns" were excluded from analyses {Harr, #1375} do not support this claim.

The current findings do not strictly support the relationship between theory of mind and contagious yawning, because there is no clear evidence supporting the presence of fully functional theory of mind in non-human animals, even in chimpanzees [26, 27]. However, it does not deny the possibility that a precursor of theory of mind may relate to the capacity for contagious yawning in these species. For example, dogs are sensitive to human attention and communication cues [28, 29], and may even infer the knowledge status of humans [30].

Conclusions and Future Directions

In this chapter, I have reviewed developmental and comparative studies of contagious yawning. Even though the scarcity of existing studies prevents us from drawing any firm conclusions, the current findings tend to suggest that contagious yawning shares the mechanism with the capacity for theory of mind. In particular, a series of studies with children with autism highlighted that spontaneous orienting to socially relevant stimuli such as eyes may mediate contagious yawning in humans and possibly in non-human animals. These suggestions from preliminary findings merit further investigation of the relationship between the development of social cognition and contagious yawning. In this final section, I will summarize some possible directions for future research.

Firstly, more studies are required to fully describe the developmental pathway of contagious yawning, as well as to assess the reasons behind the apparent contradiction between two of the existing developmental studies [2, 9] about the presence or absence of contagious yawning in children younger than 7 years. In addition, further studies are needed to test whether the absence of spontaneous contagious yawning is limited to children with autism, or can be observed other developmental disorders that may or may not manifest impairment in social cognition.

Secondly, it is critical to test the prevalence of contagious yawning in non-human animals. As our recent study demonstrated the presence of contagious yawning in domestic dogs, it is possible that other non-primate species could also have the capacity for contagious yawning. Since our dog paper [6] was featured in the media, I have received numbers of anecdotes of yawn contagion from enthusiastic amateur naturalists and pet owners, including four independent reports about cats (*Felis catus*), a report about horses (*Equus ferus caballus*), an African grey parrot (*Psittacus erithacus*), and blackbirds (*Turdus merula*), as well as a report about a failed attempt with foxes (exact species not known). Of course it is likely that these anecdotes are based on the over-interpretation of incidental episodes, but I still think it is worth investigating. At the same time, it is also important to study to what extent contagious yawning in non-human animals shares the mechanism with human yawn contagion.

Growing number of new reports have begun to shed light on the mechanism underlying contagious yawning and its relations to other cognitive mechanisms. Further studies in the neural, developmental and evolutionary origin of contagious yawning will help us to better understand the mechanism underlying yawning, as well as the mechanism underlying social interaction and communication.

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Figure Legends

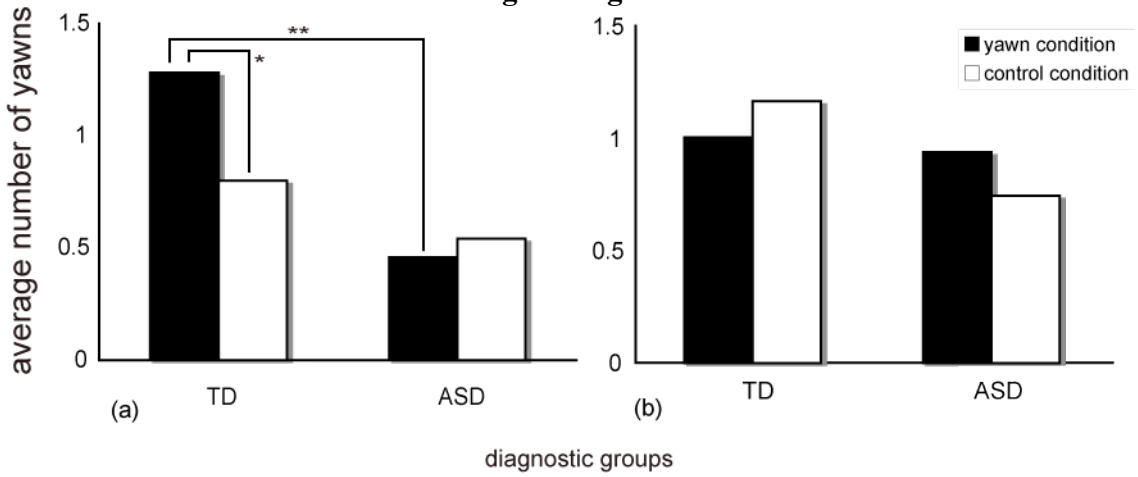

Figure 1. Average frequency of yawns of participants during or after the observation of yawn and control conditions (a) in [8] and (b) in [12]. TD, typically developing children; ASD, children with autism spectrum disorder; **, $p < .01$; *, $p < .05$. Reproduced, with permission, from [8, 12].

Figure 2. A yawn response during the presentation of a human yawn. The experimenter's face can be seen at the top of each image, which was recorded in the mirror placed behind the dog. The dog (a) observed the experimenter yawning, (b) started yawning as the experimenter finished yawning and (c) then completed yawning. Reproduced, with permission, from [6]