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Research report

Contagious yawning: the role of self-awareness and mental state attribution

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Abstract

Contagious yawning is a common, but poorly understood phenomenon. We hypothesized that contagious yawning is part of a more general phenomenon known as mental state attribution (i.e. the ability to inferentially model the mental states of others). To test this hypothesis we compared susceptibility to contagiously yawn with performance on a self-face recognition task, several theory of mind stories, and on a measure of schizotypal personality traits. Consistent with the hypothesis, susceptibility to contagiously yawn was positively related to performance on self-face recognition and faux pas theory of mind stories, and negatively related to schizotypal personality traits. These data suggest that contagious yawning may be associated with empathic aspects of mental state attribution and are negatively affected by increases in schizotypal personality traits much like other self-processing related tasks.

Theme: Neural basis for behavior

Topic: Cognition

Keywords: Contagious yawning; Mental state attribution; Self-awareness; Schizotypal personality; Schizophrenia; Emotional contagion; Self

1. Introduction

Contagious yawning, the onset of a yawn triggered by seeing, hearing, reading, or thinking about another person yawning, is a common phenomenon [22–24,28]. Here we show that individual differences in susceptibility to contagious yawning are related to performance on self-face recognition and theory of mind story tasks.

We hypothesized that contagious yawning occurs as a consequence of a theory of mind, the ability to infer or empathize with what others want, know, or intend to do [3,4,6,17–19,36]. Seeing or hearing about another person yawn may tap a primitive neurological substrate responsible for self-awareness and empathic modeling which produces a corresponding response in oneself. To test this hypothesis we examined susceptibility to contagious yawning with performance on a self-face recognition task and several theory of mind stories. Schizotypal personality traits [25,26] found in non-clinical populations that approximate similar, but less severe schizophrenic traits and are negatively correlated with performance on mental state attribution [17,18] and self-recognition tasks [21], were also measured.

2. Experiment 1: contagious yawning—the impact of Schizotypal Personality Questionnaire scores

Schizotypal Personality Questionnaire (SPQ) scores have been shown to affect an individual's ability to process information about the self [20,21]. We predicted that if contagious yawning was associated with mental state attribution then schizotypal personality traits would negatively affect susceptibility to contagiously yawn, as well.

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2.1. Methods

2.1.1. Subjects

A total of 65 (31 male, 34 female, mean age 19.8 years) undergraduate college students served as participants and received course credit for their participation. Subjects were read and explained the details of their participation, all subjects gave written informed consent, and the local institutional review board approved the study.

2.1.2. Design

2.1.2.1. Video stimuli. A total of 24 7-s digital videos of eight volunteers (four male and four female) were video recorded in three separate conditions (neutral, laughing or yawning) using digital video equipment.[1] Videos were recorded using video capture software developed by one of the authors (S.M.P.). The videos were presented to subjects using a presentation program developed using Microsoft Visual Basic 6.0. Each video appeared in a single Microsoft document window (12.1×10 cm) in the middle of a computer screen. To play the video the subject double clicked the computer mouse over any portion of the video. After watching a video the subject was asked to complete a brief 'distracter task' that consisted of responding to questions about the video. The subject then clicked on a 'NEXT' button and a new, randomly selected video appeared in the window; the procedure was repeated for all 24 videos. Participation took ~30 min. Subjects were debriefed after participation.

2.1.2.2. Observation. While subjects watched the videos an experimenter unobtrusively observed them through a one-way mirror. The experimenter coded the type of video, the subject's behavior (yawn, laugh, other, or no behavior), and the gender of the actor depicted in the video.

2.1.2.3. Schizotypal personality questionnaire. Every subject completed the Schizotypal Personality Questionnaire [25,26]. The SPQ consists of 74 YES/NO questions aimed at identifying the extent to which someone expresses schizotypal personality traits. The scale has been found to be reliable and has internal consistency and construct validity [26]. The scale takes ~10 min to complete and can be scored in several ways. We examined the total SPQ score, the subscales, and the factor analytic scores. The SPQ subscales consist of nine scales that represent individual personality trait manifestation: ideas of reference, excessive social anxiety, odd beliefs/magical thinking, unusual perceptual experiences, odd behavior, no close friends, odd speech, constricted affect and suspiciousness. The SPQ also has a consistent three factorial structure [26]: cognitive-perceptual factor (ideas of reference, odd beliefs/magical thinking, unusual perceptual experiences, and suspiciousness), interpersonal factor (excessive social anxiety, no close friends and suspiciousness), and disorganized factor (odd behavior and odd speech). Whether a subject received the computer yawning task first or the SPQ first was randomized.

2.2. Results

Observer inter-rater reliability was perfect (100%). Whether a subject completed the computer yawning task or the SPQ first had no effect. There was no effect of gender of the person in the video on whether a yawn was evoked or not, nor was there an effect on the number of times evoked yawning occurred. The incidence rate of evoked yawning in response to watching yawning videos (number of subjects who yawned at least once) was 41.5%, while the rate of evoked yawning in response to non-yawn videos was only 9%. Of those who showed contagious yawning ($n=27$) 60% yawned more than once. A Pearson product moment correlation showed that as SPQ total scores increased the incidence of evoked yawning decreased, $r(63)=-0.602$, $P<0.01$.[2]

2.3. Discussion

Our hypothesis that schizotypal personality characteristics would affect susceptibility to contagiously yawn was supported by our findings. These data suggest that schizotypal personality traits may cause changes in the way the brain processes unconscious mental state understanding.

3. Experiment 2: relationship between contagious yawning and theory of mind

In order to further test our hypothesis that contagious yawning is related to mental state attribution we compared susceptibility to contagiously yawn with performance on theory of mind tasks. We used three types of theory of mind tasks. We used three stories that assessed an individual's ability to understand that another person could hold a false belief (so-called first order false belief task [2,3,36]). We also used two stories that assessed whether an individual could think about a character's ability to hold a false belief about another character in the story (so-called second order false belief [19,33]). Finally, we also used two stories that assess an individual's ability to recognize a

[1] A sample video of a volunteer yawning is available online at http://www.evolutionarypsych.com.

[2] Evoked yawning was also negatively correlated to the unusual perceptual experiences, $r=-0.464$, $P<0.05$, and odd behavior subscales, $r=-0.483$, $P<0.05$. The cognitive-perceptual factor score was negatively correlated to evoked yawning, $r=-0.537$, $P<0.05$, and the interpersonal factor score showed a trend towards being negatively related to evoked yawning, $r=-0.436$, $P=0.55$.

social faux pas [4,30]. Specifically, because we hypothesize that contagious yawning may be a primitive empathic mechanism, we predicted that performance on understanding faux pas would correlate the greatest with susceptibility to contagiously yawn.

3.1. Methods

A randomly selected subset of 45 subjects (20 male, 25 female; mean age 20.1 years) from experiment 1 served as subjects in experiment 2. Subjects in experiment 2, in addition to being asked to complete the SPQ and measured for contagious yawning, were asked to answer several theory of mind stories [3,4,19,36].

3.2. Results

For this subset of the data evoked yawning was negatively correlated with SPQ ideas of reference ($r(43)=-0.356$, $P<0.05$), the SPQ constricted affect ($r=-0.324$, $P<0.05$), the no close friends subscales ($r=-0.525$, $P<0.01$), and the interpersonal factor score ($r=-0.316$, $P<0.05$). Performance on the faux pas theory of mind stories was negatively correlated with SPQ total scores ($r=-0.425$, $P<0.01$), the constricted affect subscale ($r=-0.430$, $P<0.01$) and the interpersonal factor score ($r=-0.515$, $P<0.01$). First and second order false belief stories were not correlated with SPQ total or SPQ subscales or factor scores. Performance on the faux pas theory of mind stories was also proportional to the incidence of evoked yawning ($r=0.392$, $P<0.05$). A Mann–Whitney *U*-test showed that those who scored 21 and above on the SPQ performed worse on the faux pas theory of mind tasks ($P<0.05$) and showed significantly less evoked yawning ($P<0.05$) than those that scored 20 and below. Performance on first and second order theory of mind stories was not significantly correlated with contagious yawning ($r=0.080$, NS and $r=0.046$, NS, respectively) (Table 1).

3.3. Discussion

Our data supported the notion that contagious yawning may be an empathic process related to theory of mind. We showed that susceptibility to contagiously yawn was related to performance on the faux pas stories but not the first or second order false belief tasks. These data suggest that contagious yawning may be occurring as a result of unconscious empathic modeling. This effect may be mediated in part by unconscious mental simulation carried out by so-called mirror neurons [1,27] that have been implicated in imitative behaviors and mental state attribution [35,37].

Table 1
Percent correct on theory of mind stories as a function of contagious yawning

	Contagious yawn	
	Yes (N=19)	No (N=26)
First order Fast belief	87%	88%
Second order False belief	86%	87%
Faux pas Score	97%	66%

4. Experiment 3: relationship between contagious yawning and self-face recognition

According to a model developed over two decades ago, mental state attribution presupposes self-awareness, i.e. in order to engage in mental state attribution an individual must be able engage in self-introspection [7,8,11,12]. Keenan et al. [14,15] have shown a left-hand advantage for self-face recognition. Platek and colleagues have demonstrated that the left-hand advantage for processing information about the self is negatively impacted by schizotypal personality traits [20,21]. Therefore, we predicted that hand advantage for self-face recognition would correlate with contagious yawning. Specifically, we predicted that subjects who showed contagious yawning would also show a left-hand advantage for self-face processing.

4.1. Methods

A randomly selected subset of 21 subjects from experiment 1 (ten male, 11 female; mean age 19.8 years) served as subjects in experiment 3. Subjects were asked to identify their own face or the face of two strangers using the computer keyboard. Previous research has shown that when compared to responding to familiar or strange faces there is a left-hand advantage for identifying self-faces [14,15], which implicates the right cortical hemisphere [15,16].

4.1.1. Design

Subjects were seated ~35–40 cm from a computer screen, and shown a series of faces: their own face and the faces of two strangers using SuperLab experiment design software (Cedrus, version 2.01). All faces were gender and aged matched within 5 years. Each face was assigned a specific key on the computer keyboard (e.g. self-face was 'V' key, stranger 1 was 'B' key, etc.). Upon seeing a face, subjects were instructed to respond using the appropriate key as accurately and as quickly as possible in a three-button alternative choice task. Each time a subject made a response the next image automatically appeared. Key-face assignments were randomized, i.e. whether a particular key was assigned to a specific face was randomized between

Table 2
Mean (±S.E.M.) reaction times to self and other faces as a function of contagious yawning

	Contagious yawn	
	Yes (N=9)	No (N=12)
Self-face		
Left-hand	771.42 (±46.67)	837.85 (±53.89)
Right-hand	817.66 (±48.17)	782.15 (±55.62)
Other face		
Left-hand	868.02 (±48.20)	859.62 (±55.66)
Right-hand	872.65 (±44.69)	846.00 (±51.60)

subjects. Subjects responded twice with their left-hand and twice with their right-hand. Hand order was randomized between subjects (e.g. LRLR, RLRL, LRRL, etc.). As much practice as needed was allowed for all subjects to (i) feel comfortable with the procedures and (ii) achieve a 90% accuracy rate.

Each block consisted of responding with one hand to a series of 120 faces: 20 self-faces right side up, 20 self-faces upside down, 20 stranger 1 faces right side up, 20 stranger 1 faces upside down, 20 stranger 2 faces right side up, and 20 stranger 2 faces upside down. There were four blocks so that each subject completed 40 trials utilizing each stimulus.

4.2. Results

Subjects were split into two groups: those that showed contagious yawning and those that did not (Table 2). Those who showed evoked yawning were faster (mean 771.42 ms) at responding to their self-face with their left-hand than those who did not show evoked yawning (mean 837.85 ms) ($F(3,57)=7.07$, $P<0.01$). A repeated measures analysis of variance (ANOVA) showed that there was a difference in responding to the faces as a function of SPQ score ($F(3,57)=5.95$, $P<0.01$). Fisher's L.S.D. post hoc analysis revealed that those subjects who scored 21 or higher on the SPQ were slower to respond to self-faces using the left-hand (mean 836.82 ms) than those who scored 20 and below (mean 728.77 ms) ($P<0.01$), which supports Platek and Gallup [21] who showed the same effect in a different sample. There were no reaction time differences in responding to the other faces (Table 2).

4.3. Discussion

These data support the notion that contagious yawning is related to processing information about the self and suggest that normal self-processing in the right hemisphere may be mediating susceptibility to contagious yawning.

5. General discussion

Thus, in contrast to those that were unaffected by seeing someone yawn, people who showed contagious yawning identified their own faces faster, did better at making inferences about mental states, and exhibited fewer schizotypal personality characteristics. These results suggest that contagious yawning might be related to self-awareness and empathic processing. Our data also imply that contagious yawning may reside in brain substrates which have been implicated in self-recognition [13–16,21,29,34] and mental state attribution [5,6,17,19,31,34], namely the right prefrontal cortex.

In conclusion, since high scores on the SPQ were negatively correlated with contagious yawning, and SPQ is related to schizophrenia symptomatology [18], schizophrenic patients should show little or no contagious yawning given that they also show a deficit in their ability to both recognize themselves and attribute mental states to others. Further, we would hypothesize that only those species that exhibit self-recognition and mental state attribution (humans, chimpanzees [9], and orangutans [32]) ought also exhibit contagious yawning [8–12].

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References

[1] M.A. Arbib, A. Billard, M. Iacoboni, E. Oztop, Synthetic brain imaging: grasping, mirror neurons, and imitation, Neural Networks 13 (2000) 975–997.
[2] S. Baron-Cohen, The autistic child's theory of mind: a case of specific developmental delay, Psychiatry 30 (1989) 285–297.
[3] S. Baron-Cohen, A.M. Leslie, U. Frith, Does the autistic child have a theory of mind?, Cognition 21 (1985) 37–46.
[4] S. Baron-Cohen, M. O'Riordan, R. Jones, K. Plaisted, Recognition of faux pas by normally developing children with Asperger's syndrome or high-functioning autism, J. Autism Dev. Disord. 29 (1999) 407–418.
[5] C.D. Frith, Functional brain imaging and the neuropathology of schizophrenia, Schizophr. Bull. 23 (1997) 525–527.
[6] C.D. Frith, R. Corcoran, Exploring 'theory of mind' in people with schizophrenia, Psychol. Med. 26 (1996) 521–530.
[7] G.G. Gallup Jr., S.M. Platek, Cognitive empathy presupposes self-awareness: evidence from phylogeny, ontogeny, neuropsychology, and mental illness, Behav. Brain Sci. 25 (2002) 36–37.
[8] G.G. Gallup Jr., J.R. Anderson, S.M. Platek, Self-awareness, social intelligence, and schizophrenia, in: A.S. David, T. Kircher (Eds.), The Self and Schizophrenia: A Neuropsychological Perspective, Cambridge University Press (in press).
[9] G.G. Gallup Jr., Chimpanzees: self-recognition, Science 167 (1970) 86–87.
[10] G.G. Gallup Jr., Self-awareness and the emergence of theory of mind in primates, Am. J. Primatol. 2 (1982) 237–248.

[11] G.G. Gallup Jr., Towards a taxonomy of mind in primates, Behav. Brain Sci. 11 (1988) 255–256.
[12] G.G. Gallup Jr., Can animals empathize?, Sci. Am. 9 (1998) 66–71.
[13] J.P. Keenan, N.B. McCutcheon, A. Pascual-Leone, Functional magnetic resonance imaging and event related potentials suggest right prefrontal activation for self-related processing, Brain Cogn. (in press).
[14] J.P. Keenan, N.B. McCutcheon, S. Freund, G.G. Gallup Jr., G. Sanders, A. Pascual-Leone, Left hand advantage in a self-face recognition task, Neuropsychologia 37 (1999) 1421–1425.
[15] J.P. Keenan, M.A. Wheeler, G.G. Gallup Jr., A. Pascual-Leone, Self-recognition and the right prefrontal cortex, Trends Cogn. Sci. 4 (2000) 338–344.
[16] W.S. Kremen, S.V. Faraone, R. Toomey, L.J. Seidman, M.T. Tsuang, Sex differences in self-reported schizotypal traits in relatives of schizophrenic probands, Schizophr. Res. 34 (1998) 27–37.
[17] R. Langdon, M. Coltheart, Mentalizing, schizotypy, and schizophrenia, Cognition 71 (1999) 43–71.
[18] R. Langdon, M. Coltheart, Visual perspective taking and schizotypy: evidence for a simulation based account of mentalizing in normal adults, Cognition 82 (2001) 1–26.
[19] J. Perner, H. Wimmer, 'John thinks that Mary thinks . . . ': attribution of second-order beliefs by 5- to 10-year-old children, J. Exp. Child Psychol. 39 (1985) 437–471.
[20] S.M. Platek, T.E. Critton, S.R. Critton, G.G. Gallup Jr., Left-hand advantage for self-description: the impact of schizotypal personality traits, Schizophr. Res. (in press).
[21] S.M. Platek, G.G. Gallup Jr., Self-face recognition is affected by schizotypal personality traits, Schizophr. Res. 57 (2002) 311–315.
[22] R.R. Provine, Faces as releasers of contagious yawning: an approach to face detection using normal human subjects, Bull. Psychon. Soc. 27 (1989) 211–214.
[23] R.R. Provine, Contagious yawning and infant imitation, Bull. Psychon. Soc. 27 (1989) 125–126.
[24] R.R. Provine, B.C. Tate, L.L. Geldmahcer, Yawning: no effect of 3–5% CO_2, 100% O_2, an exercise, Behav. Neural Biol. 48 (1987) 382–393.
[25] A. Raine, The SPQ: a scale for the assessment of schizotypal personality based on DSM-III-R criteria, Schizophr. Bull. 17 (1991) 556–564.
[26] A. Raine, Sex differences in schizotypal personality in a non-clinical population, J. Abnorm. Psychol. 101 (1992) 361–364.
[27] G. Rizzolatti, L. Fadiga, L. Fogassi, V. Gallese, Resonance behaviors and mirror neurons, Arch. Ital. Biol. 137 (1999) 85–100.
[28] G. Schino, F. Aureli, Do men yawn more than women?, Ethol. Sociobiol. 10 (1989) 375–378.
[29] K. Spangenberg, A. Wagner, W. Bachman, Neuropsychological analysis of a case of abrupt onset following a hypotensive crisis in a patient with vascular dementia, Neurocase 4 (1998) 149–154.
[30] V.E. Stone, S. Baron-Cohen, A. Calder, J. Keane, A. Young, Acquired theory of mind impairments in individuals with bilateral amygdala lesions, Neuropsychologia 41 (2003) 209–220.
[31] D.T. Stuss, G.G. Gallup Jr., M.P. Alexander, The frontal lobes are necessary for theory of mind, Brain 124 (2001) 279–286.
[32] S.D. Suarez, G.G. Gallup Jr., Self-recognition in chimpanzees and orangutans, but not gorillas, J. Hum. Evol. 10 (1981) 175–188.
[33] H. Tager-Flusberg, K. Sullivan, A second look at second order belief attribution in autism, J. Autism Dev. Disord. 24 (1994) 577–586.
[34] K. Vogely, P. Bussfeld, A. Newen, F. Happe, P. Falkai, W. Maier, N.J. Shah, G.R. Fink, K. Zilles, Mind reading: neural mechanisms of theory of mind and self-perspective, Neuroimage 14 (2001) 170–181.
[35] J.H. Williams, A. Whiten, T. Suddendorf, D.I. Perrett, Imitation, mirror neurons, and autism, Neurosci. Biobehav. Rev. 25 (2001) 287–295.
[36] H. Wimmer, J. Perner, Beliefs about beliefs: representation and constraining function of wrong beliefs in young children's understanding of deception, Cognition 13 (1983) 103–128.
[37] A. Wohlschlager, H. Bekkering, Is human interaction based on a mirror-neurone system? Some behavioural evidence, Exp. Brain Res. 143 (2002) 335–341.