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Contagious yawning and psychopathy

Brian K. Rundle *, Vanessa R. Vaughn, Matthew S. Stanford

Baylor University, Department of Psychology and Neuroscience, One Bear Place 97334, Waco, TX 76798, United States

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ABSTRACT

Psychopathy is characterized by a general antisocial lifestyle with behaviors including being selfish, manipulative, impulsive, fearless, callous, possibly domineering, and particularly lacking in empathy. Contagious yawning in our species has been strongly linked to empathy. We exposed 135 students, male and female, who completed the Psychopathic Personality Inventory-Revised (PPI-R), to a yawning paradigm intended to induce a reactionary yawn. Further, we exposed males to an emotion-related startle paradigm meant to assess peripheral amygdalar reactivity. We found that scores on the PPI-R subscale Coldheartedness significantly predicted a reduced chance of yawning. Further, we found that emotion-related startle amplitudes were predictive of frequency of contagious yawning. These data suggest that psychopathic traits may be related to the empathic nature of contagious yawning in our species.

1. Yawning and psychopathy

Yawning is a stereotyped behavior that, in our evolutionary history, has clear, deep roots as evidenced by its proliferation in mammals as well as many other vertebrates (Argiolas and Melis, 1998; Lehmann, 1979). It is clearly characterized by long inspiration followed by a shorter expiration (Argiolas and Melis, 1998). While literature concerning the pharmacology and functional anatomy of yawning is not lacking (Argiolas and Melis, 1998; Guggisberg, Mathis, Schnider, and Hess, 2010; Nahab, Hattori, Saad, and Hallett, 2009), the primary facet of yawning of interest is the phenomena of contagious yawns, specifically within the context of psychopathology.

Contagious yawns, which are spurred by yawn, thinking, hearing, reading, or observing another conspecific (or other species), have been linked to empathy (Lehmann, 1979; Platek, Critton, Myers, and Gallup, 2003; Platek, Mohamed, and Gallup, 2005). They are even documented in other familiar animals such as *Pan Troglodytes* and *Canis Familiaris* and have been linked to empathy (Campbell and de Waal, 2011; Romero, Konno, and Hasegawa, 2013). The anatomy and pharmacology of yawning and its contagious nature are beginning to be investigated, with oxytocin playing a large role as well as the posterior cingulate cortex (PCC), precuneus, bilateral thalamus, and parahippocampal gyrus (PHG) (Platek et al., 2005; Sanna, Argiolas, and Melis, 2012). Interestingly, Schürmann et al. (2005) found that the mirror-neuron system is not directly activated in contagious yawning, suggesting that the action is automatic and not imitated. Norscia and Palagi (2011) found that people show a large susceptibility to contagious yawns when elicited by a related individual in terms of occurrence and frequency of yawns. For strangers, they found that people show a marked latency period of contagious yawns, strongly suggesting a component of familiarity involved with the contagion.

Variations in susceptibility to contagious yawning are already known to occur in certain populations. Age is known to affect the likelihood of contagious yawning; as age increases, contagious yawning decreases (Bartholomew and Cirulli, 2014). Further, children on the autism spectrum are less likely to demonstrate contagious yawning (Giganti and Esposito Ziello, 2009; Senju et al., 2007), which is speculated to have a strong relationship to the empathetic deficits seen in this population.

1.1. Psychopathy

Empirical support for yawning having its evolutionary roots in empathic behavior is growing (Campbell and de Waal, 2011). Psychopathic traits, then, become a curious angle in which to view contagious yawning in our species. Psychopathy is characterized by a general antisocial lifestyle including being selfish, manipulative, impulsive, fearless, callous, domineering, and particularly lacking in empathy (Hare, 2003; Weber, Habel, Amunts, and Schneider, 2008). The disorder is typically assessed via the Psychopathic Check List-Revised (PCL-R) developed by Hare (2003) or the Psychopathic Personality Inventory (PPI-R) developed by Lilienfeld and Widows (2005). Psychopathy and its close relative Antisocial Personality Disorder are found overwhelmingly in males (Cale and Lilienfeld, 2002). Additionally, psychopathy carries specific brain abnormalities including structural and functional impairments of the orbitofrontal–ventromedial prefrontal cortex as well as the amygdala (Gao, Glenn, Schug, Yang, and Raine, 2009; Weber et al., 2008).

* Corresponding author.
E-mail address: Brian_rundle@baylor.edu (B.K. Rundle).

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The PPI-R operationalizes two discrete components within psychopathy: a primary (affective) and secondary (behavioral) facet (Hare, 2003; Lilienfeld and Widows, 2005), where the primary facet encompasses features including cruelty, lack of affect and empathy, while the secondary facet encompasses features such as impulsivity and aggression. Psychopaths demonstrate an overall small but marked decrease in the ability to recognize emotion in others (Kosson, Suchy, Mayer, and Libby, 2002; Wilson, Juodis, and Porter, 2011), which is also associated with decreased amygdalar function, particularly with fearful faces (Jones, Laurens, Herba, Barker, and Viding, 2009). Kosson et al. (2002) showed a slight overall decreased ability to recognize emotion, but a large deficit in recognizing disgust in others when the task involved non-verbal responses. It has also been shown that psychopaths fail to exhibit a conditioned response to aversive Pavlovian conditioning (Flor, Birbaumer, Hermann, Silvio, and Patrick, 2002), which suggests deficiencies in amygdala-dependent memory.

What sets psychopathy apart from its close relatives Conduct Disorder and Antisocial Personality Disorder is its distinct emotional component. That is, psychopathy involves a prevalent emotional profile consisting of a considerable reduction in or lack of empathy (Frick, O'Brien, Wooton, and McBurnett, 1994; Hare, 2003). Psychopathy has also been found to be inversely related to the ability to perceive emotion (in both male and females) and managing emotion (only in men) (Lishner, Swim, Hong, and Vitacco, 2011).

1.2. Hypothesis

Given the nature of psychopathy and yawning discussed herein, the current study aims to examine the relationship between contagious yawning and psychopathic traits. This will be examined both by a yawning paradigm designed by the current researchers (modeled after Platek et al., 2005) as well as an emotion-related startle paradigm (ERS) previously used in Anderson, Stanford, Wan, and Young (2011). Affective potentiation of the acoustic startle reflex (by Electromyograph [EMG] and Galvanic skin response [GSR]) is one of the most prominent psychophysiological measures of amygdalar responsiveness (Davis, 1989; Lang, Bradley, and Cuthbert, 1990; LeDoux, Iwata, Cicchetti, and Reis, 1988). Psychopaths reliably demonstrate an impairment of potentiation of the startle reflex (Patrick, Bradley, and Lang, 1993), while healthy controls reliably potentiate with negative affective valence and attenuate the fear response with positive affective valences (Lang et al., 1990). What's more, Patrick et al. (1993); Patrick (1994) connected the lack of potentiated startle in psychopathy to the emotional facet of the PCL-R (Hare, 2003) while the behavioral facet was found to be unrelated. Further, given the growing evidence that contagious yawning and empathy are evolutionarily related, a connection between psychopathy and yawning maintains sufficient precedence. To our knowledge, such an examination has not been done in high psychopathic trait individuals, nor have contagious yawning been addressed using ERS. In our case, we expect to find a connection between psychopathic traits and a decreased susceptibility to contagiously yawn.

2. Methods

In these experiments, a total of 135 college male and female participants were selected based on their completion of the PPI-R (Lilienfeld and Widows, 2005). Psychopathic traits were operationalized as a spectrum and no arbitrary cut-off was used for high and low traits unless noted. The PPI-R has three primary factors: Fearless Dominance (FD)/Self-Centered Impulsivity (SCI; behavioral and interpersonal aspects), and Coldheartedness (CD; social emotional aspect).

2.1. Experiment one: yawn

2.1.1. Participants

For the yawning paradigm, one hundred and thirty five university students, males ($n = 57$) and females ($n = 78$), were used. All participants completed the same yawning paradigm intended to induce a reactive yawn. Participants were excluded from the analyses if they resisted yawning or did not pay attention to the presentation.

2.1.2. Yawn paradigm

Videos of individual males and females unknown to any participants were selected to provide 7-10 second videos of a yawn, a laugh, or a neutral face. This paradigm follows the methods listed in Platek et al. (2005), a method shown to induce yawns. Participants viewed a series of video blocks. Each block consisted of three videos (yawning, neutral-face, and smile) in random order. To be clear, each video block did not contain the videos from one individual, but rather a pseudo-random and exhaustive selection of yawns, laughs, or neutrals from a pool of videos recorded from strangers. Each individual video was 7–10 s long and, thus, each block was 24–33 s long (with a one second interval between each video in the video block). Ten seconds of a blank black screen separated each block and participants viewed 20 blocks.

2.1.3. Procedure

Participants were instructed to sit in a padded chair in a dimly lit, radiofrequency anechoic chamber (Raymond EMC Enclosures Ltd. Ottawa). Participants sat in front of a computer monitor and wore noise canceling headphones. They were asked to relax for one minute's time. They were told that they would be watching a movie of different people's expressions that they need to remain comfortably seated, and to keep their attention on the screen. Further, if they felt the need to adjust themselves, laugh, cough, yawn, or blink, that they were allowed to do so as long as their attention remained on the screen and that they would return to a still, comfortable position.

Facial EMG was recorded from the orbicularis oculi muscle of the participant's right eye. A pair of Ag–AgCl electrodes (Biopac Systems Inc., Goleta, CA, USA) was placed one centimeter below the eyelid, with one directly below the pupil and the other one centimeter to the right of the first. A third electrode was placed directly in the middle of the forehead to serve as a ground. Prior to placing the electrodes, skin was prepared with an isopropyl alcohol rub and a mildly abrasive gel (NuPrep) to improve surface conductance. Signa gel brand saline gel was used as a conducting medium and impedances were kept below 5 kΩ. Hardware used to collect EMG signals was BioPac MP150 data acquisition hardware using a sampling rate of 2000 Hz and a 10–500 Hz bandpass filter. EMG data were rectified and integrated with a time constant of 10 ms.

GSR was also obtained. Electrodermal activity was recorded by securing Ag–AgCl to the index and ring finger of the participants. Skin was prepped by removing surface oils with isopropyl alcohol followed by the application of isotonic NaCl electrode paste. Hardware used to collect GSR data was BioPac MP150 data acquisition hardware using a sampling rate of 2000 Hz and a 0.5–1 Hz bandpass filter. For both EMG and GSR, data was recorded with AcqKnowledge 4.1 Software (BioPac Systems Inc.).

Unlike Platek et al. (2005), we were simply interested in inducing yawns. As a validation measure, EMG, GSR, and direct video observation of the participant were utilized. That is, a clear physiological characterization of a yawn was necessary for the behavior to be considered a full yawn. This was in order to distinguish related behaviors such as sighs and heavy inspirations as well as to validate video observations. Electrophysiologically, we defined a yawn as sustained EMG impedance paired with a delayed GSR (see Fig. A.1