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Contagious Yawning, Empathy, and Their Relation to Prosocial Behavior

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Humans express facial mimicry across a variety of actions. This article explores a distinct example, contagious yawning, and the links to empathy and prosocial behavior. Prior studies have suggested that there is a positive link between empathy and the susceptibility to contagious yawning. However, the existing evidence has been sparse and contradictory. We present results from 2 laboratory studies conducted with 171 (Study 1) and 333 (Study 2) student volunteers. Subjects were video-recorded while watching muted videos of individuals yawning, scratching, or laughing. Empathy was measured using the Interpersonal Reactivity Index. Although subjects imitated all facial expressions to large extents, our studies show that only contagious yawning was related to empathy. Subjects who yawned in response to observing others yawn exhibited higher empathy values by half a standard deviation. However, we found no evidence that the susceptibility to contagious yawning is directly related to prosocial behavior.

Keywords: contagious yawning, empathy, prosocial behavior, social coordination, mimicry

Supplemental materials: http://dx.doi.org/10.1037/xge0000422.supp

Humans are social beings. They are highly skilled in interpreting the facial expressions and gestures of other humans and in responding to the signals, expectations, and behaviors encoded in these actions. Some forms of emotional and behavioral imitation appear unconsciously and within milliseconds (e.g., Chartrand & Bargh, 1999; Dimberg, Thunberg, & Elmehed, 2000). Other reactions are more conscious and context-dependent (see Hess & Fischer, 2013, for a recent review). Both strands of the literature have suggested that mimicry, be it conscious or unconscious, facilitates social cohesion and coordination in groups (e.g., Lakin, Jefferis, Cheng, & Chartrand, 2003). The existing evidence has suggested that mimicry works in two ways: First, the mimickee infers from the imitation of his behavior or gestures that others understand his intentions or emotions. Second, the mimicker enhances his empathy with the person he imitates. Thus, Stel, Van Baaren, and Vonk (2008) showed that subjects who were instructed to mimic others also have higher levels of empathy for the imitated person. Hence, mimicking others can elevate empathy, which in turn increases prosocial behavior even toward others not related to the mimicking.

Also, the relation between empathy and prosocial behavior has been much discussed in the literature (Batson, 1991; Batson & Moran, 1999; de Waal, 2012; Eisenberg & Miller, 1987; Galinsky, Maddux, Gilin, & White, 2008; Stocks, Lishner, & Decker, 2009). Some authors have suggested that empathy is an unpleasant emotion (e.g. Batson, 1991). One way of reducing it is to either escape situations in which empathy emerges or help those in need. This hypothesis has been termed the *aversive−arousal reduction hypothesis* (Batson, 1991). According to the hypothesis, prosocial behavior is basically a selfish response. An alternative mechanism is that empathy highlights an altruistic perspective. So far, most evidence has supported this *empathy−altruism hypothesis* (Doris & Stitch, 2007; Nichols, 2004; Stocks et al., 2009).

In this article, we focus on a distinct and peculiar phenomenon of mimicry, namely the contagiousness of yawning. Humans, like most vertebrates, yawn occasionally. The existing evidence has suggested that it is induced by sleepiness (e.g. Provine, 2005). Yawning increases the oxygen content of the blood and lowers the brain temperature, functioning as a wake-up call (Gallup & Gallup, 2007, 2008; Guggisberg, Mathis, Schnider, & Hess, 2011; Provine, 2005; Zilli, Giganti, & Uga, 2008). However, yawning can also be contagious. Former studies have suggested that about 40% to 60% of humans are susceptible to contagious yawning (e.g., Gallup, Church, Miller, Risko, & Kingstone, 2016), and there is also evidence that it is contagious among some animals, like chimpanzees, dogs, and wolves (e.g., Romero, Ito, Saito, & Hasegawa, 2014; Romero, Konno, & Hasegawa, 2013).

Moreover, some studies have suggested that the susceptibility of contagious yawning is linked to the degree of empathy (Lehmann, 1979; Norscia et al., 2016b; Palagi, Leone, Mancini,

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& Ferrari, 2009; Provine, 1986, 2005). For instance, Platek, Critton, Myers, and Gallup (2003) found that individuals who are more sensitive to contagious yawning also recognize social faux pas in written reports better than do subjects who are not susceptible to it. Yawning is also more contagious among individuals with close social ties, compared to strangers (Norscia, Demuru, & Palagi, 2016b; Norscia & Palagi, 2011; Palagi, Norscia, & Demuru, 2014). Moreover, Haker and Rössler (2009) found that individuals with schizophrenic disorders are less sensitive to contagious yawning and also display lower empathy values compared to healthy individuals. Further evidence stems from studies in neuroscience that use functional magnetic resonance imaging. These results suggest that the urge to yawn when observing others yawning is related to neural activity in those areas of the brain that are involved in assessing self-referent information (Arnott, Singhal, & Goodale, 2009; Brown et al., 2017; Cooper et al., 2012; Haker, Kawohl, Herwig, & Rössler, 2013; Platek, Mohamed, & Gallup, 2005).

To sum up, research so far has suggested that asking individuals to imitate others elevates their empathy and that empathy in turn increases prosocial behavior. In this article we investigate a slightly different question. We study the link of contagious yawning and empathy if researchers do not actively encourage the mimicry. Hence, we investigate whether the susceptibility of contagious yawning is also an indicator of individuals' baseline empathy level. Some existing evidence on contagious yawning has suggested this link. However, other studies have shown counterevidence. Particularly, a study by Bartholomew and Cirulli (2014) using 328 subjects found no evidence that contagious yawning is related to empathy. Besides its comparatively large sample, the study by Bartholomew and Cirulli has the advantage of measuring empathy directly via the Interpersonal Reactivity Index (IRI), whereas studies reporting positive evidence relied on indirect measures such as the faux-pas test or the auxiliary assumption that empathy is higher among closer social ties.

But Bartholomew and Cirulli's (2014) study also has some disadvantages. First, subjects had to self-report whether they yawned. Measuring yawning by self-report has the disadvantage of leaving the measurement to the subjects and their interpretation and thus withdraws it from the control of the experimenter. Second, the experimenters informed subjects of the phenomenon of contagious yawning before they participated in the study, which may have stimulated the social desirability of contagious yawning. Yawning was reported by 67% of their subjects, which is a higher incidence of yawning than reported in other studies. The high incidence could have obscured the difference between yawners and nonyawners with respect to empathy. Furthermore, Bartholomew and Cirulli did not use any control group in their study. Therefore, it remains unclear what the rate of yawning would have been if subjects had watched other stimulus videos of nonyawning faces. This makes the distinction between yawning that occurs spontaneously and yawning that occurs due to contagion impossible.

Taken together, the empirical evidence on whether contagious yawning is related to empathy is still unclear, and the existing evidence contradictory (e.g., Massen & Gallup, 2017). Studies that found positive evidence did not employ direct measurements of empathy (e.g., by using the IRI), and the study that found no evidence (Bartholomew & Cirulli, 2014) used a weak measure of the occurrence of contagious yawning. To gain further insight into the phenomenon of contagious yawning and its relation to empathy, we conducted two studies with large samples of healthy volunteers. Study 1 was conducted in a manner very similar to that in the Bartholomew and Cirulli (2014) study. However, we videotaped subjects while they were watching the stimulus videos and coded the occurrence of yawning from these videos. Because prior studies have proposed that empathy is an important prerequisite of altruism and prosocial behavior (Batson & Moran, 1999; de Waal, 2012; de Waal & Preston, 2017; Eisenberg & Miller, 1987; Galinsky et al., 2008; Stocks et al., 2009), we extend the existing literature on contagious yawning by also investigating whether it is directly related to prosocial behavior. In Study 1, the test consisted of a dictator game in which subjects had the opportunity to donate some (or all) of their endowment to an anonymous recipient. Because Study 1 also did not involve a control group, we conducted a second study, in which subjects were randomized into either a treatment group or a control group. In the treatment group, subjects watched videos of laughing faces, people scratching or touching their face or hair, and yawning faces. In the control group, subjects watched only laughing and scratching subjects. This experimental procedure allowed us to determine the natural occurrence of spontaneous yawning in comparison to contagious yawning. Moreover, it also allowed us to test whether other forms of mimicry (scratching and laughing) are related to empathy. We also measured prosocial behavior in Study 2 by giving subjects the opportunity to donate some (or all) of their experimental payment to a charitable organization.

Summing up, we investigated three hypotheses (see Figure 1): Hypothesis A postulates that empathy is positively related to prosocial behavior. Hypothesis B suggests that empathy varies among individuals and that the susceptibility of contagious yawning is an indicator of empathy. Hypothesis C suggests that those who show contagious yawning also more likely show prosocial behavior.

The remainder of the article proceeds in as follows: First, we describe the method used in Study 1, followed by the results. Then

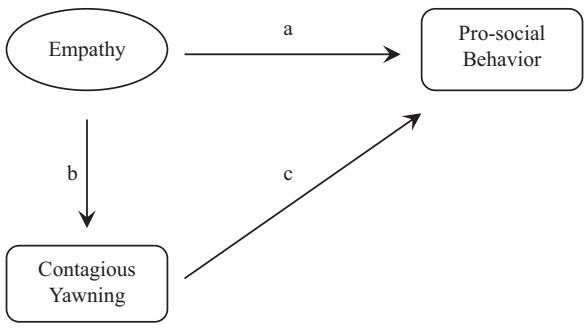

Figure 1. Summary of the hypotheses: (a) postulates that empathy is positively related to prosocial behavior; (b) suggests that empathic individuals are susceptible to contagious yawning and that it is an indicator of empathy; (c) suggests that those who show contagious yawning are also more likely to show prosocial behavior.

Table 1
The Four Dimensions of the Interpersonal Reactivity Index (IRI) Used in the Experiment

Dimension and items	Study 1	Study 2
Perspective taking		
1. I try to look at everybody's side of a disagreement before I make a decision.	.80	.75
2. I believe that there are two sides to every question and try to look at them both.	.76	.75
3. When I am upset with someone, I usually try to put myself in his shoes for a while.	.54	.65
4. Before criticizing somebody, I try to imagine how I would feel if I were in their place.	.65	.73
Fantasy		
5. I really get involved with the feelings of the characters in a novel.	.65	.61
6. After seeing a play or movie, I have felt as though I were one of the characters.	.70	.74
7. When I watch a good movie, I can very easily put myself in the place of a leading character.	.84	.72
8. When I am reading an interesting story or novel, I imagine how I would feel if the events in the story were happening to me.	.65	.73
Empathetic concern		
9. I often have tender, concerned feelings for people less fortunate than me.	.72	.74
10. When I see someone being taken advantage of, I feel kind of protective towards them.	.69	.58
11. I am often quite touched by things that I see happen.	.52	.61
12. I would describe myself as a rather soft-hearted person.	.52	.68
Personal distress		
13. In emergency situations, I feel apprehensive and ill-at-ease.	.67	.70
14. I sometimes feel helpless when I am in the middle of a very emotional situation.	.73	.80
15. Being in a tense emotional situation scares me.	.79	.78
16. I tend to lose control during emergencies.	.42	.41
N	171	333
Cronbach's α	.77	.73

Note. Values indicate factor loadings after varimax rotated exploratory component factor analysis in Studies 1 and 2.

we discuss the limitations of Study 1 and describe the method used in Study 2, which responds to the limitations of Study 1 and extends the existing evidence. Specifically, Study 2 investigates whether other forms of facial mimicry are also indicators of empathy. Then we report the results of Study 2. Finally, the results of both studies are summarized and discussed.

Study 1

Method

Study 1 was conducted to replicate the findings of Bartholomew and Cirulli (2014). We recruited 191 students from various academic disciplines of the University of Bern between March 24 and April 29, 2015, conducting 22 experimental sessions with five to 10 subjects each in the university's lab. Upon arrival in the lab, subjects were seated in cubicles in front of computers, which were equipped with a video camera (pictures of the lab are included in the online supplemental materials; see Figure S1). Subjects first played a dictator game via paper and pencil to measure prosocial behavior (Eckel & Grossman, 1996; Klimecki, Mayer, Jusyte, Scheeff, & Schönenberg, 2016). Subjects were told that they would receive 10 Swiss francs (about US$10), which they could share in any way they wanted with another person randomly drawn from the university's student population. They were told that the identity of the recipient would not be disclosed to them. Because donation behavior is heavily influenced by subjects' anonymity (Franzen & Pointner, 2012), we took great care that the experimental staff could not associate any donated amount to a specific subject (see the online supplemental materials for a detailed description of the instructions).

After completion of the dictator game, the experimental staff switched on the computers and the cameras and attached a pulse meter (Contec CMS60C) to subjects' forefingers. We then showed subjects a 3-min video of yawning faces of different individuals of various ages and both sexes. Subjects were video-recorded while watching this stimulus video. The videos were later coded according to whether subjects yawned while watching the stimulus video, how many times they yawned, and at which time(s) during the experiment yawning occurred. The stimulus video was followed by an online questionnaire, which contained a short version (16 items) of the Interpersonal Reactivity Index (IRI; Davis, 1983; Paulus, 2009) to measure empathy as well as a few questions on individuals' energy level and some sociodemographic characteristics of the subjects.

Because yawning occurs not only by contagion but also because of sleepiness (Provine, 2005), we tried to measure subjects' sleepiness by using the pulse meter. Prior studies have shown that yawning due to sleepiness is accompanied by a falling pulse rate (Carrington et al., 2005; Corey, Shoup-Knox, Gordis, & Gallup, 2012). Additionally, we measured sleepiness by using the Circadian Energy Scale (CIRENS; Ottoni, Antoniolli, & Lara, 2011).

Before starting the camera and applying the pulse meter, we provided a detailed description of both appliances on the screen. In particular, subjects were informed about the process of data collection and measures to keep results anonymous. Subjects explicitly had to consent to being video-recorded by clicking an *accept* button on the computer screen. Six of the 191 subjects did not agree to being video-recorded and left the experiment.

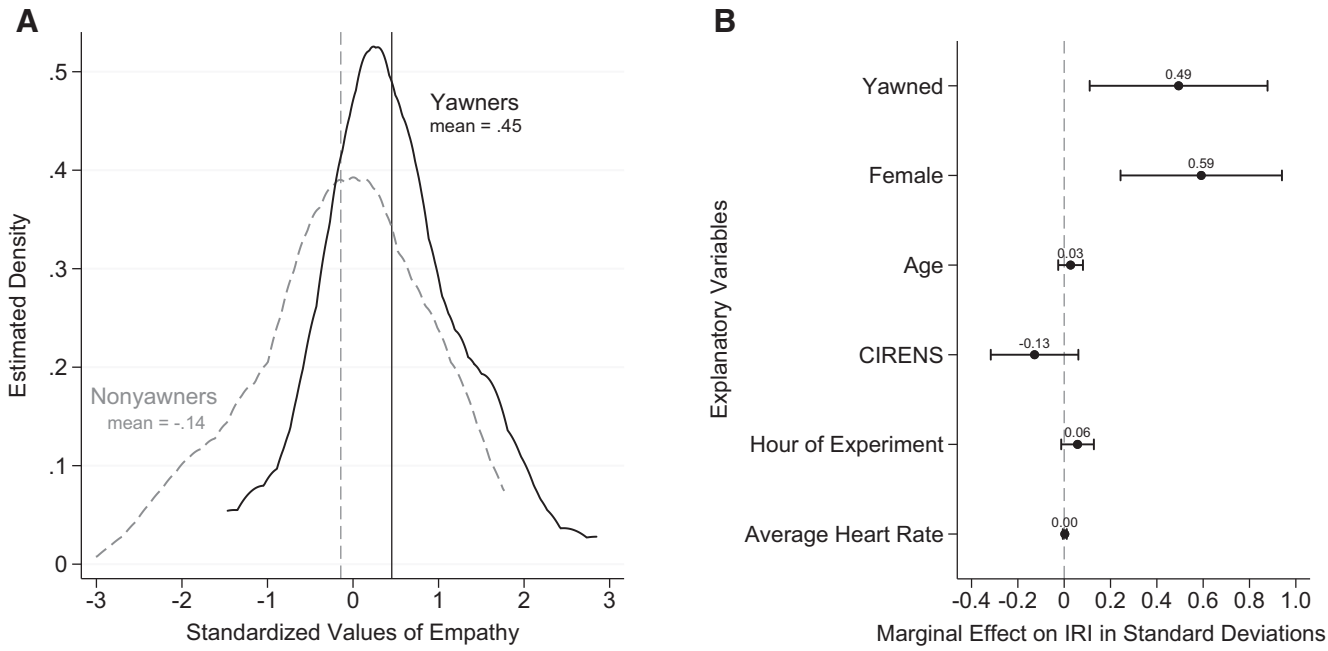

Figure 2. The distribution of empathy and predictors of empathy in Study 1. The plot in Panel A shows Kernel density estimates ($n = 171$) of the z-standardized distribution of empathy among individuals not showing contagious yawning (dashed gray curve; $n = 130$) and individuals who did show contagious yawning (solid black curve; $n = 41$) as measured by the Interpersonal Reactivity Index (IRI). Nonyawners had .59 standard deviation lower empathy values than did yawners (−.14 vs. .45), suggesting that contagious yawning is a visual indicator of empathy. This difference in means (as indicated by the dashed and solid vertical lines) was statistically significant, $t(169) = 3.43$, $p < .001$. Panel B represents the coefficient plot of the ordinary least squares regression of the z-standardized IRI on its predictors and contagious yawning (see Model 3 in Table S1 in the online supplemental materials; $n = 128$, adjusted $R^2 = .13$), including the 95% confidence intervals. CIRENS = Circadian Energy Scale. The dashed vertical line refers to the null effect.

A further 14 faces were not fully visible in the videos, making the coding of whether yawning occurred or not impossible. This left us with 171 valid cases for analysis. Furthermore, the pulse meter did not work correctly in every case, and in one session the data were lost due to technical difficulties. Hence, Study 1 had 128 complete cases for those analyses that took pulse rates into account.[1]

Results

Sixty-five of the 171 subjects in Study 1 were male (38%), and the average age of was 23.8 years ($SD = 3.08$, range = 18−37). Table 1 displays the 16 items of the IRI, which measure empathy. Each item is rated on a 5-point scale ranging from 1 (*never*) to 5 (*always*). Consistent with former research, an exploratory factor component analysis revealed that the 16 items fell into four subdimensions referred to as *perspective taking, fantasy, empathetic concern,* and *personal distress.* The additive index of all 16 items reached a high level of reliability, as indicated by a Cronbach's alpha of .77. The personal distress subdimension is sometimes excluded from analysis, because it measures self-management rather than empathy. Our results were robust if this dimension is excluded (see Table S1 and Figure S2 in the online supplemental materials).

Twenty-four percent of our subjects yawned at least once while watching the stimulus video. Those who did yawn had a mean value of .45 on the standardized IRI (z-standardized; $M = 0$, $SD = 1$) compared to −.14 for subjects who did not yawn. This difference is more than half a standard deviation on the empathy scale and is highly statistically significant, $t(169) = 3.43$, $p < 0.001$. A comparison of the distribution of those who yawned and those who did not is visualized in Figure 2A. Because yawning can also occur spontaneously due to subjects' sleepiness or possible boredom during the experiment (Gallup & Gallup, 2007, 2008; Guggisberg et al., 2011; Provine, 2005; Zilli et al., 2008), we controlled for sleepiness by measuring the subjects' pulse rate and general activity level via the Circadian Energy Scale (CIRENS; Ottoni et al., 2011). The average pulse rate was 74.5 beats per minute for subjects who did yawn and 76.7 for those who did not. This difference is not statistically significant, $t(126) = .65$, $p = .51$, which is in line with the assumption that the yawning observed was induced by conta-

[1] The ethical standard of both experiments was approved by the Faculty of Business Administration, Economics and Social Sciences of the University of Bern, and the experiments were strictly carried out in accordance with the guidelines outlined by the Declaration of Helsinki (World Medical Association, 2013).

gion and not by sleepiness (see also Figure S3 in the online supplemental materials).

The CIRENS was recoded in such a way that it measured the general energy level of subjects in the morning, for those who also participated in morning sessions, and accordingly the general energy level in the afternoon or evening, for those who participated in afternoon or evening sessions. Furthermore, we took the subjects' age and sex into consideration. We then analyzed the variance of empathy via a multiple ordinary least squares (OLS) regression with the IRI as the dependent variable controlling for the various indicators of sleepiness. The results of this analysis, displayed in Figure 2B, reveal that subjects who yawned still had .49 standard deviation higher empathy values as measured by the IRI even controlling for the indicators of sleepiness (pulse rate, CIRENS values, time of day the experiment took place). None of these indicators affected the empathy score. Further analyses revealed that all subdimensions of the IRI were positively related to contagious yawning. However, the association was not statistically significant with respect to perspective taking and personal distress (see Table S2 in the online supplemental materials). Our results also suggest that women have higher empathy. The OLS coefficient indicated that women were on average .59 standard deviation higher on the IRI compared to men, which mirrored the results of other studies (e.g., Chan & Tseng, 2017; Norscia et al., 2016b; Willer, Wimer, & Owens, 2015).

Next, we turn to the results concerning the donation behavior in the dictator game. Yawners donated on average 3.59 of the 10 Swiss francs to the anonymous recipient, whereas nonyawners averaged 2.95 francs. This difference is in the expected direction but is not statistically significant, $t(169) = 1.45$, $p = .15$; Mann–Whitney U test $z = 1.87$, $p = .06$; see Figure 3).

This result was also confirmed by a multiple OLS regression of the amount donated on contagious yawning including other covariates such as subjects' sex, age, IRI, and the measurement of sleepiness. The results of the OLS regression (see Figure 4) show that empathy as measured by the IRI is related to giving in the dictator game, confirming previous findings (e.g., Klimecki et al., 2016). This was also true for the subcomponents of the IRI except personal distress (see Table S4 in the online supplemental materials). However, contagious yawning was not directly linked to subjects' donation in the dictator game. Hence, our data do not support the notion that the susceptibility to contagious yawning is directly related to prosocial behavior (Hypothesis C).

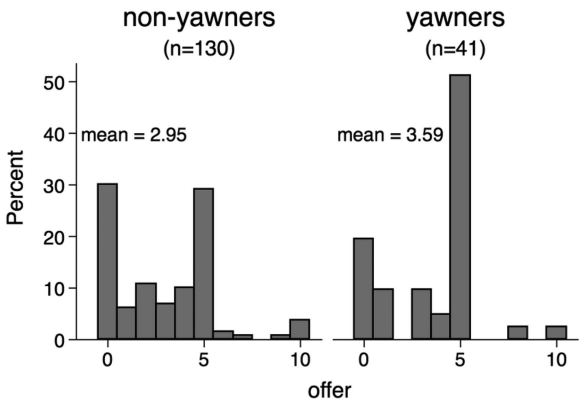

Figure 3. Donation in the dictator game by yawners and nonyawners in Study 1. The figure displays the offers in Swiss francs made by subjects not showing contagious yawning (left side) and those showing contagious yawning (right side). Yawners gave slightly more than did nonyawners; however, this difference was not statistically significant.

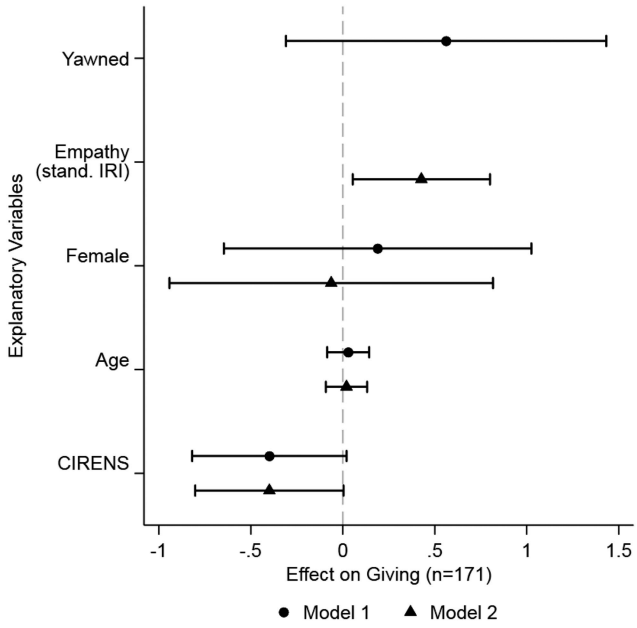

Figure 4. The figure displays the coefficient plot of the ordinary least squares regression of donation behavior in the dictator game on its predictors, including the 95% confidence intervals, in Study 1 (see also Table S3 in the online supplemental materials). Stand. = standardized; IRI = Interpersonal Reactivity Index; CIRENS = Circadian Energy Scale. The dashed vertical line refers to the null effect.

Study 2

Method

Study 1 has some limitations. Like the study by Bartholomew and Cirulli (2014), it did not involve a control group. Hence, it is unclear whether the yawning observed was elicited by contagion or was spontaneous and would have happened even if the subjects had not watched yawning faces. Furthermore, Study 1 raises the question whether contagious yawning is unique or whether the mimicry of other facial expressions is also related to empathy. To answer these questions, we conducted the second study.

Study 2 was conducted with 363 student volunteers from various disciplines of the University of Bern in 46 sessions with five to 10 subjects each 1 year later (March 22 to April 14, 2016). There are four important differences compared with Study 1. First, subjects were randomized into either a treatment group or a control group. In the treatment group, subjects first watched videos of individuals of different sexes and ages touching their face or hair (e.g., scratching their nose) for 1.5 min, followed by a video sequence of 1.5 min of laughing faces and finally a 3-min video of yawning individuals. We integrated the scratching and laughing

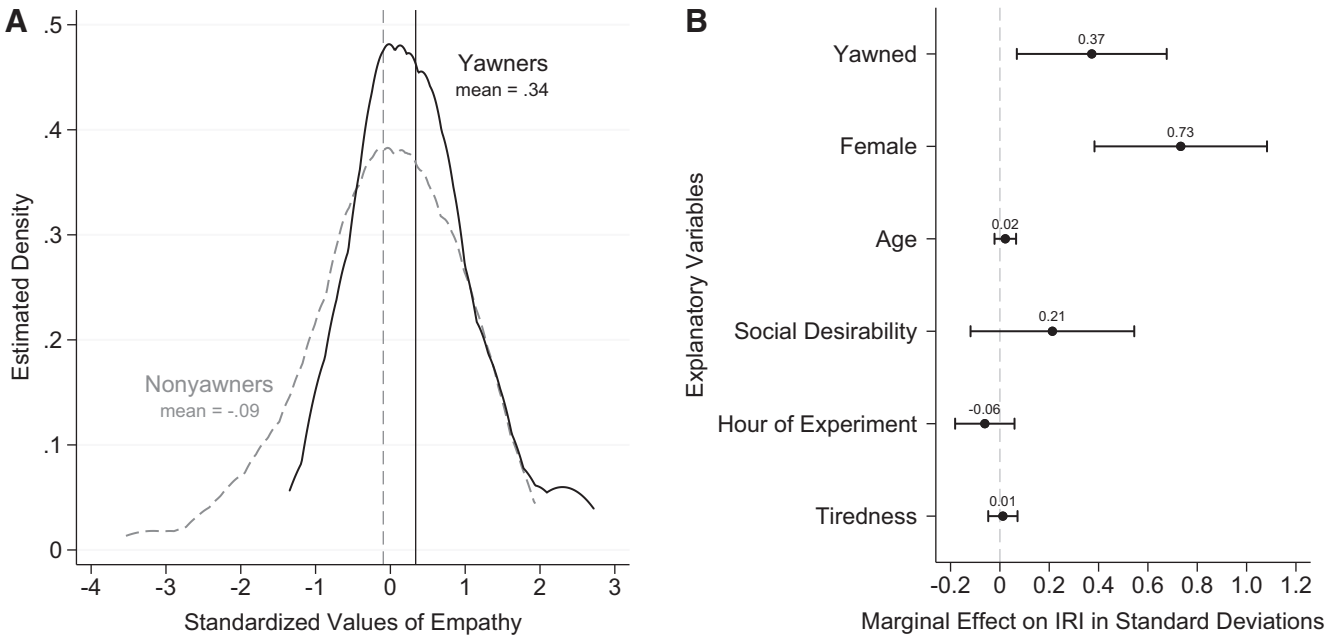

Figure 5. The distribution of empathy and predictors of empathy in Study 2. The plot in Panel A shows Kernel density estimates ($n = 183$) of the z-standardized distribution of empathy as measured by the Interpersonal Reactivity Index (IRI) among individuals in the treatment group not showing contagious yawning (dashed gray curve; $n = 143$) and individuals who did show contagious yawning (solid black curve; $n = 40$). Yawners have .43 standard deviation higher empathy values than do nonyawners (.09 vs. .34). The means are indicated by the vertical dashed and solid lines. This difference in means was statistically significant, $t(181) = 2.73$, $p = .008$. Panel B represents the coefficient plot of the ordinary least squares regression of the z-standardized IRI on its predictors (see Model 4 of Table S5 in the online supplemental materials; $n = 183$, adjusted $R^2 = .12$) in the treatment group, including the 95% confidence intervals. The dashed vertical line indicates the null effect.

faces into the treatment group to better conceal the purpose of the study from subjects. In the control group, subjects watched only individuals scratching their face for 2 min and laughing for 4 min but not yawning individuals.[2] We could also have split the exposure time to 3 min each in the control group. However, as it turned out, the exposure times of scratching and laughing faces did not make a difference in terms of imitation rates. In both groups, the videos lasted for 6 min.

Second, instead of using the dictator game, we measured prosocial behavior by offering subjects the opportunity to donate some (or all) of the experimental payment to a charitable organization at the end of the experiment. Donating money in a dictator game to an anonymous person is relatively abstract, particularly if it is unknown whether the recipient is in need. There has been debate about whether giving in the dictator game measures prosocial behavior or instead fairness or altruism. The latter are related to prosocial behavior but not completely identical. To employ an alternative measure of prosocial behavior, in Study 2 we gave subjects a list of the most well known charitable organizations and gave them the opportunity to donate some (or all) of the payment of 20 Swiss francs (about US$20) they received for participating in the experiment.

Third, we measured subjects' tiredness by directly asking how tired they felt during the experiment, rated on an 11-point scale ranging from 0 (*not at all tired*) to 10 (*very tired*). Fourth, we also included a measure of social desirability in the questionnaire. Subjects were given a list with four tourist sites in the city of Bern and a list with four publicly known personalities. One of the four answers in each list was a fictional name. Subjects who answered that they knew the fictional person or the fictional tourist site could be more susceptible to social desirability, which might affect their susceptibility to contagious yawning as well as empathy, as measured by the IRI. Hence, social desirability could distort the results.

Results

We recruited 363 subjects for Study 2. However, 30 faces were not fully visible in the videos, leaving us with 333 valid subjects.[3] Overall, 71.2% (237) of subjects were female, and subjects' age ranged from 19 to 34 years, with a mean of 23.6 ($SD = 2.91$). The randomization was done via the software *z-tree* (Fischbacher, 2007), which was also used for the questionnaire. It assigned 183 subjects to the treatment group and 150 to the control group. The

[2] Even through the exposure time of laughing faces differed in the groups, there was no statistical difference of imitation. In the treatment group, 60% of subjects smiled in response to laughing faces. In the control group, 56% smiled. The difference is not statistically significant, $t(331) = .75$. The same results applied to face scratching (22% vs. 29%), $t(331) = 1.31$.

[3] These 30 cases did not differ statistically from the valid observations regarding the assignment to treatments, sex distribution, and Interpersonal Reactivity Index values.

proportion of women, mean age, and mean empathy values (overall mean of IRI = 54.04, treatment group IRI = 53.60, and control group IRI = 54.55) did not differ statistically significant between the treatment and control groups. The videos of the subjects were coded according to whether subjects scratched their face, laughed, or yawned while watching the corresponding videos. In the treatment group, 22% (40/183) of subjects yawned. In the control group, only 3.3% (5/150) yawned, confirming the notion that practically all yawns in the treatment group occurred because of contagion. Subjects who showed contagious yawning in the treatment group also displayed higher empathy values by .43 standard deviation as measured by the IRI. The results are depicted in Figure 5A.

Furthermore, in the treatment group, 22.4% of subjects scratched their face in response to the scratching video sequence, and 60.1% laughed during the laughing sequence. In the control group, the incidence of scratching and laughing was 28.7% and 56%, respectively. However, neither in the control group nor in the treatment group was either scratching or laughing related to empathy values (see Table S7 in the online supplemental materials).

In Study 2, we also measured subjects' susceptibility to social desirability. Subjects who answered "yes" to knowing the fictional tourist site or person were coded as being sensitive to social desirability. The results of the OLS regression are displayed in Figure 5B and show that besides yawning and gender, none of the included control variables (age, tiredness, social desirability, and time of the day the experiment took place) is related to empathy. Further analyses on the subdimensions of IRI revealed that contagious yawning was statistically significantly related to fantasy taking and empathetic concern and hence comprises both an affective and a cognitive aspect of empathy (see Table S6).

Furthermore, we analyzed via logistic regression which subjects decided to donate some (or all) of their experimental payment of 20 Swiss francs to a charitable organization. The results reveal (see Figure 6) that only empathy predicted the probability of donating. Hence, contagious yawning is an indicator of empathy, which in turn predicts charitable giving. But contagious yawning had no direct effect on charitable giving.

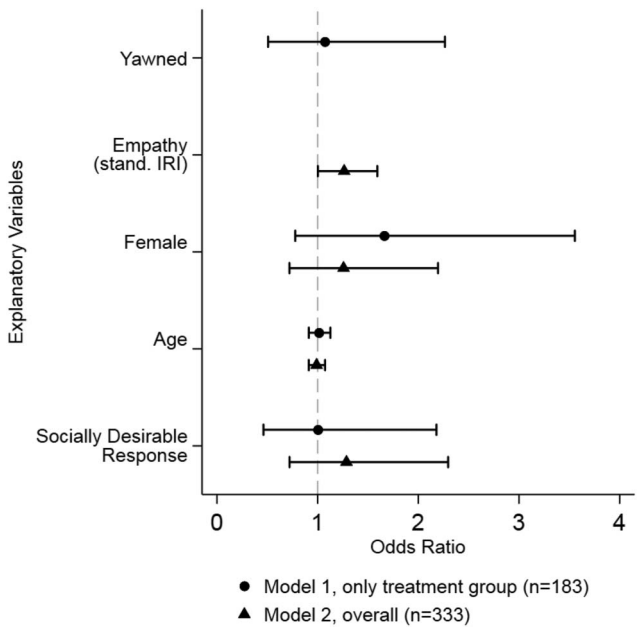

Figure 6. The figure displays the coefficient plot of the logistic regression of donation to a charitable organization on its predictors, including the 95% confidence intervals, in Study 2 (see also Table S8 in the online supplemental materials). Further analyses of the subdimensions of the Interpersonal Reactivity Index (IRI) show that all were positively related to donating (except the personal distress subdimension) even though not every dimension was statistically significant (see Table S9 in the online supplemental materials). Stand. = standardized. The dashed vertical line indicates an odds ratio of 1 referring to the null effect.

Discussion

This study found clear evidence that susceptibility to contagious yawning is related to empathy. In Study 1, 24% of the subjects yawned, and yawning subjects showed higher empathy values by .49 standard deviation when compared to nonyawning subjects. This result was closely replicated in Study 2, in which 22% of the subjects yawned in response to the stimulus video. Our finding confirms results of previous research, which showed indirect evidence of yawning's being related to empathy (Arnott et al., 2009; Norscia et al., 2016b; Norscia & Palagi, 2011; Palagi et al., 2014; Platek et al., 2003, 2005), and disconfirms the missing evidence reported by Bartholomew and Cirulli (2014). We believe that the association between contagious yawning and empathy was obscured in the Bartholomew and Cirulli study for methodological reasons. The authors informed subjects beforehand about the nature of contagious yawning, and they relied on the subjects' self-reporting to measure the occurrence of yawning. In contrast, we recorded the subjects on video and thus have a more objective and reliable measure of the occurrence of yawning.

The contagion rate of 24% that we found is comparatively low. One reason for this might be that subjects watched the stimulus videos while other subjects were also present in the laboratory. All workplaces were separated by cubicles in such a way that subjects' faces were not directly observable by other subjects. However, the mere presence of others in the same room might have inhibited contagious yawning, as suggested by Gallup et al. (2016).

Furthermore, Study 2 shows that other mimicry, for example, face scratching or laughing, is not an indicator of empathy. This finding is not in contradiction with the results of Stel et al. (2008), who instructed subjects to imitate others and found elevated empathy levels afterward. But our results suggest that the simple occurrence of a smile while watching others smile or laugh is not an indicator of empathy, as is contagious yawning. Taken together, these results suggest that contagious yawning is a special and distinct phenomenon. It is hard to control and seems to be biologically ingrained in highly social species, such as monkeys, apes, and humans. Highly social species must often rely on the synchronization of behavior, particularly in situations of escaping from predators, coordinating sleep–wake cycles, or adhering to social norms. Hence, it might have been evolutionarily advantageous to be highly susceptible to the emotions and intentions of others, and authors like de Waal (2008) have suggested that empathy provides the basis for synchronized motor action and synchronizes emotional states. This, in turn, has positive feedback effects on social cohesion (Palagi et al., 2009; Seyfarth & Cheney, 2013) and

promotes helping behavior and identification with conspecifics (Preston & de Waal, 2002).

Our study found positive evidence for only Hypotheses A and B and not for Hypothesis C, that contagious yawning has a direct link to prosocial behavior. Yawning subjects did donate more money to an anonymous recipient in the dictator game (Study 1). However, the difference between yawners and nonyawners was not statistically significant. The same results held true with respect to donating to a charitable organization (Study 2). Hence, contagious yawning is a signal of empathy, but the signal is not very strong or clear. However, using a measure of general empathy and general prosocial behavior (as we did) does not take context into consideration. The relation between contagious yawning and prosocial behavior might indeed be stronger if the prosocial behavior is specific and directed toward members of one's own group.

Moreover, the degree of empathy is also determined by other factors such as gender (as also shown by our results) or presumably through education and socialization (not tested here). Norscia et al. (2016b) and Chan and Tseng (2017) reported that female subjects were more susceptible to contagious yawning. Also, in our studies, women were more susceptible to contagious yawning (24.4%) than were men (19.6%). However, this difference is not statistically significant, $\chi^2(1, N = 354) = .97, p = .32$, confirming the results of various other studies (e.g., Gallup & Massen, 2016). However, the IRI shows clearly higher values for women. Hence, we also conclude that women are more empathetic than are men, presumably because women are "hard-wired for maternity and parental care" (Norscia et al., 2016b, p. 1; for a detailed discussion of the gender effect, see also Norscia, Demuru, & Palagi, 2016a).

It is interesting that, and not easily explained why, only contagious yawning, and not scratching or laughing, was related to empathy in our study. One interpretation is that scratching, and more so laughing, are more easily controllable behaviors. Individuals might have learned that it is socially expected to imitate a smile or laugh. However, yawning is much harder to control or to suppress, and it is therefore harder to be shaped by cultural factors. We believe that the study results represent an important finding and indicate avenues for further research. First, susceptibility to contagious yawning seems to be an implicit test of empathy. Second, the finding that contagious yawning is not generally related to prosocial behavior raises questions about whether this association can be found in groups of closer social ties (e.g., as parochial prosocial behavior) along the lines suggested by De Dreu et al. (2010).

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