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"Touch Me If You Can!": Individual Differences in Disease Avoidance and Social Touch

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Abstract

The threat of diseases varies considerably among individuals, and it has been found to be linked to various proactive or reactive behaviors. In the present studies, we investigated the impact of individual differences in the perceived vulnerability to disease (PVD) on social touch before (Study 1) or during the coronavirus disease 2019 (COVID-19) pandemic (Study 2). We also investigated the influence of personality traits in the covariation between these two dimensions. We found that people who are the most disease-avoidant are also the most reluctant to touching or being touched by others (and this relationship holds when personality traits are taken into account). Interestingly, the association between PVD and social touch increased during the COVID-19 pandemic compared with a few months before. By showing that the fear of contamination has an association with *social touch*, the findings provide further evidence for the behavioral immune system (Schaller and Park, 2011), a psychological system acting as a first line of defense against pathogens.

Keywords

perceived vulnerability to disease, social touch, pathogens, personality, behavioral immune system, COVID-19

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> "Touch me, touch me. I want to feel your body. Your heartbeat next to mine (This is the night). Touch me, touch me now." This excerpt from a song entitled "Touch me" by Samantha Fox (1986) reminds us that social touch between intimate partners, which is incredibly powerful, is one of the greatest pleasures in life (Cascio et al., 2019).

Social touch: positive and negative sides

Like their close primate relatives (chimpanzees, bonobos), humans belong to a highly social species (DeWaal, 2010). Indeed, we cannot live in good health without regular social and physical contacts (House et al., 1988). In romantic couples, for instance, touch and well-being are positively associated (Debrot et al., 2021). As a result, certain adults who are socially isolated have their immune system compromised (Pressman et al., 2005), and it has been shown that social isolation is associated with higher mortality (Steptoe et al., 2013). Social touch, which corresponds to situations in which individuals touch each other, appears to be a universal need (Olausson et al., 2010). According to Cascio et al. (2019), a clear criterion for social touch is the fact that it is interpersonal, that is to say it is shared between individuals having a reciprocal relationship with one another. In effect, touch can be intimate as in sexual intercourse, or it can be casual between strangers, for example in the case of an assistant and customer in a bakery or two people standing close to each other in the bus. Social touch is an important factor shaping the development of the brain from the very beginning of life, during childhood and

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adolescence, and also in adulthood (Cascio et al., 2019). However, individuals vary in their propensity for "social touch." To evaluate the behavior and attitudes toward social touch, a questionnaire consisting of 20 Likert-scale items (e.g., "It would make me feel anxious if someone I had just met touched me on the wrist", "I greet my close friends with a kiss, cheek-to-cheek") was designed by Wilhelm et al. (2001).

The negative side of physical touching is that it may increase the probability of catching diseases, most of which are transmitted directly by close physical contacts such as kisses or shaking hands or indirectly by touching objects that are likely to transmit diseases. Being touched by someone who is contaminated, for instance by SARS-CoV-2 (Severe Acute Respiratory Syndrome Coronavirus 2), can potentially compromise one's health because this virus is responsible for coronavirus disease 2019 (COVID-19). Being physically touched when the risk of contracting a disease is high, for instance during the time of an outbreak, can therefore be a great source of threat (Qu et al., 2020).

The Behavioral Immune System: A Proactive System to Protect Against Diseases

Diseases are caused by pathogens (e.g., viruses, bacteria). They cannot be seen by the naked eye, and thus they represent invisible threats that can cause a high cost to their hosts (Ewald, 1993; Lagrue, 2020). They appeared on earth at the very beginning of life and thus have been present for a longer time than the Hominines (Pin, 2015). In fact, pathogens have been one of the most powerful selection pressures throughout the history of our species (Fumagalli et al., 2011), and they are responsible for the greatest number of deaths in the history of humanity, more than all of other causes of death put together (e.g., accidents, wars, disasters) (Inhorn and Brown, 1990). A common source of disease is other people, and many pathogens are specifically adapted for human-to-human transmission (Aarøe et al., 2016). Pathogens are still a great source of threat as the COVID-19 pandemic that the World has faced (SARS-CoV-2) reminded us at the time this paper was being written (Troisi, 2020).

Natural selection has built a set of components in humans designed to detect—albeit imperfectly—cues of pathogens[1] and inhibit contact with potential sources of contamination: The Behavioral Immune System (BIS) (Ackerman et al., 2018; Murray and Schaller, 2016; Schaller, 2006, 2011, 2016; Schaller and Park, 2011). The BIS is a proactive system in contrast to the biological immune system, which is a reactive system—also designed by natural selection—to attack pathogens that penetrate the body (Richtel, 2019; Sompayrac, 2016). The biological immune system is metabolically costly (Baracos et al., 1987; Schaller and Duncan, 2007; Schrock et al., 2020). Indeed, when sick people's resources are diverted from other fitness-enhancing behaviors (e.g., mating). An important component of the BIS is disgust (Oaten et al., 2009; Schaller and Park, 2011), a basic emotion which can be seen as a kind of alarm that automatically activates a strong avoidance response (Rozin et al., 2000; Shook et al., 2019). *Pathogen disgust* in particular is thought to motivate avoidance of contact with infectious microorganisms (Tybur et al., 2013). The BIS is thus ultimately activated to prevent or reduce physical contacts with contaminated individuals (especially those who are perceived as contagious, Crandall and Moriarty, 1995) or with things that have been contaminated by pathogens (Schaller et al., 2003; Tybur et al., 2014). The BIS is not unique to humans given that animals also avoid infected conspecifics—mice avoid mating with an infected partner (Kavaliers et al., 2003), tadpoles avoid swimming with infected conspecifics (Kiesecker et al., 1999)—or contaminated things—domestic ungulates avoid grazing areas infected by faeces and prefer to move to cleaner places (Brambilla et al., 2013).

Contextual and Individual Influences in the Activation of the BIS

Although all people possess a BIS, this system is more or less highly activated depending on individual dispositions and/or situations (e.g., the flu in winter in the northern hemisphere; the COVID-19 pandemic), and its sensitivity therefore varies. Some people are more chronically attuned to the threat (real or not) of pathogens than others (Makhanova et al., in press). The BIS is likely to be more highly activated in the former than in the latter individuals. Individual variations in the activation of the BIS can be evaluated via self-administrated questionnaires such as the Disgust Scale (Haidt et al., 1994), the Three Domain Disgust Scale (Tybur et al., 2009), or the Perceived Vulnerability to Disease (PVD, Duncan et al., 2009) scale. In the literature, there is evidence that individuals who are more disgust-sensitive and/or who perceive themselves to be more vulnerable to disease display more xenophobic attitudes (e.g., Aarøe et al., 2017; Faulkner et al., 2004; Petersen, 2017), more ethnocentrism (Navarrete and Fessler, 2006; Navarrete et al., 2007), are more prone to endorse conservative ideological positions[2] (e.g., Aarøe et al., 2020; Shook et al., 2017; Terrizzi et al., 2013 for a meta-analysis), and are less inclined to trust other people (Aarøe et al., 2016; Olivera-La Rosa et al., 2020). They are also more conformist (Murray and Schaller, 2012). Interestingly and more directly related to the issue investigated here, research has shown that individuals who have greater levels of trait pathogen avoidance tend to be less interested in social affiliation in general (Sacco et al., 2014; Sawada et al., 2018), and tend to show more social distancing (Olivera-La Rosa et al., 2020; Park, 2015).

As reviewed above, the BIS is an adaptation designed to preemptively detect, and subsequently avoid, potentially sources of contamination, including conspecifics (Ackerman et al., 2018; Murray and Schaller, 2016; Schaller, 2006, 2011, 2016; Schaller and Park, 2011). At the same time, as hypersocial creatures, we also have adaptations to seek and maintain social contacts, including physical contacts (Gardner et al., 2005). Indeed, humans have an imperative need to belong (Baumeister and Leary, 1995). Social exclusion leads to an experience of pain

in a similar way to physical pain (Eisenberger and Lieberman, 2004; Eisenberger et al., 2003), and acute isolation causes social craving in the same way as fasting causes hunger (Tomova et al., 2020). Socially excluded individuals are highly motivated to reaffiliate and several mechanisms become activated in the service of achieving this goal (e.g., Brown et al., 2019b; DeWall et al., 2009; Epley et al., 2008; Maner et al., 2007; Powers et al., 2014). Collective protection during epidemics, such as social distancing measures and the related use of quarantine, makes it possible to slow down the propagation of pathogens (e.g., Thu et al., 2020 in the case of the COVID-19 pandemic). But at the same time, such collective behaviors have deleterious outcomes in the domain of social relationships because they run counter to our hypersociality (DeWaal, 2010; Tomasello, 2014). Some level of coordination is required given that the outputs of these adaptations can result in conflicts (Al-Shawaf et al., 2016; e.g., going to visit a friend who is suffering from a severe cold in order to have fun but taking the risk of becoming ill). People with dispositionally or situationally high disease avoidance may display lower motivation for affiliative behaviors in order to adaptively mitigate contacts with vectors of contamination (see Brown and Sacco, 2016; Sacco et al., 2014; Sawada et al., 2018). By contrast, people may be more inclined to take the risk of contracting a disease when their social affiliation needs are increased (e.g., Sacco et al., 2014). Thus, individuals must make important trade-offs between the need for social-physical contacts and the motivation to avoid disease (Tybur et al., 2020). During an acute pandemic, the threat of contracting a disease (here COVID-19) is likely to push the trade-off in the direction of preferring to avoid infection rather than having social contact.

Aims of the Present Studies

Given that diseases can be transmitted by physical contact, and more specifically by touch (e.g., by the hands, Grant and Hofmann, 2011), we anticipate that people who fear becoming ill the most should be less prone to social touch. Thus far, such a link has never been tested empirically, but it clearly stems from the BIS. In the present research, we were primarily concerned with the interplay between individual differences in disease avoidance as indexed by the PVD scale (Duncan et al., 2009) and the propensity to social touch (Wilhelm et al., 2001).

Certain personality traits have been found to be linked to disease avoidance (Duncan et al., 2009), and according to a recent meta-analysis (Oosterhoff et al., 2018), disease avoidance correlates most strongly with neuroticism, followed by conscientiousness, openness to new experience, and extraversion. By contrast, agreeableness was not correlated with the avoidance of pathogenic threats. Thus, although our primary focus was to test a link between disease avoidance (as indexed by PVD measures) and social touch, we additionally considered the relationships between these personality dimensions, PVD, and social touch.

BIS theory predicts that a highly salient society-wide pathogen threat—such as the COVID-19 pandemic—should lead to more negative attitudes towards physical contact, to a higher PVD and, perhaps, to the exhibition of higher levels of conscientiousness and neuroticism coupled with lower levels of openness to experience and extraversion during the time that the threat is most salient. These predictions were tested in a second study that was run on a subsample of participants taken from the first study during March 2020, a time during which the pandemic was especially virulent in France, where the questionnaires were completed.

In short, we addressed the following research questions in two studies in which data were collected in two samples of young adults before (Study 1) and during the COVID-19 pandemic (Study 2): (1) In a nonpandemic context (before the COVID-19 crisis), what is the relationship between PVD and social touch? Additionally: what are the relationships between PVD and social touch when personality traits are taken into account? (2) In the pandemic context of the COVID-19 crisis: Has the pandemic increased negative attitudes towards PVD, social touch, and their relationship? Besides these two main research questions, additionally: (3) Has the pandemic influenced personality traits and their relationship with PVD?

Study 1. Social Touch, Vulnerability to Disease, and Personality Traits BEFORE the COVID-19 Pandemic

Method

Participants. Two hundred adults (mean age 20.06 years; age range: 17-46) were involved in this study. Most of them (186) were students in psychology at the University of Bourgogne Franche-Comté. The sample was predominantly female (N = 176). The participants were all native speakers of French and received course credits for their participation. They were recruited online through the social media platform Facebook since there are groups of Facebook psychology students. Participants were also recruited by means of the "Facebook students" friendship network. Data collection took place on November 25 and 26, 2019. At this time, SARS-CoV-2 was spreading in Asia, but it had not yet spread in France.

A sensitivity analysis using G × power (Faul et al., 2007) showed that a sample size of 200 participants makes it possible to detect a hypothesized correlation of .175 with a power of .8 at the .05 α-level in a one-tailed test. This correlation value is somewhat lower than the value estimated between germ aversion and neuroticism on the basis of the recent meta-analysis performed by Oosterhoff et al. (2018) and nearly the same as that estimated between germ aversion and conscientiousness from the same study. It is reasonable to expect a higher correlation between germ aversion and social touch avoidance. To obtain a similar power for the estimated correlations with the other personality traits as reported by Oosterhoff et al. (2018) a drastic increase of the sample size would be required (more than 500 participants would be necessary to get the same power for the correlation between germ aversion and openness (-.11), which was the next highest after the correlations with neuroticism and conscientiousness).

Questionnaires and Procedure. The survey was created with Limesurvey (www.limesurvey.com) and was performed online by the participants. On the first page of the online survey, the participants provided informed consent. The participants were then required to report demographic information such as age, gender, native language, and their educational level. Next, three questionnaires were self-administered: the PVD questionnaire, the social touch questionnaire and the BIG-5. The BIG-5 was always completed second, and the PVD and the social touch questionnaire were completed in first or third position depending on the participants. The PVD and the social touch questionnaires were first translated into French by the authors and then checked by a professional native-speaking translator of English.

PVD Questionnaire. Individual differences in pathogen-avoidance motivation were assessed using the PVD questionnaire (Duncan et al., 2009) which consists of two subscales. The first subscale corresponds to "perceived infectability" with seven items such as "If an illness is going around, I will get it," "In general, I am very susceptible to colds, flu, and other infectious diseases." The second subscale is "germ aversion" with eight items such as "I prefer to wash my hands pretty soon after shaking someone's hand," "I don't like to write with a pencil someone else has obviously chewed on." Participants provide their agreement with each statement by means of seven-point Likert scales (1 = strongly disagree vs. 7 = strongly agree).

French Version of the BIG-5. The participants had to complete the BFI-FR (Plaisant et al., 2010), which is the French version of the BIG-5 (Costa and McCraei, 1992). This personality questionnaire consists of 45 items (evaluated from 1 = strongly disapprove, to 5 = strongly approve) grouped into five dimensions (Openness, Conscientiousness, Extraversion, Agreeableness, and Neuroticism).

Social Touch Questionnaire (STQ). The social touch questionnaire (STQ: Wilhelm et al., 2001) evaluates the extent to which individuals appreciate touching (e.g., "I would rather avoid shaking hands") and being touched (e.g., "I feel uncomfortable when someone I don't know very well hugs me") in a social context. Participants provide their agreement with each statement by means of Likert scales (0 = strongly disagree vs. 4 = strongly agree). High scores mean strong avoidance of social touch. The study took about 20 min to complete.

All the study procedures were approved by the Statutory Ethics Committee of the University Clermont Auvergne.

Results and Discussion of Study 1

What is the Relationship Between PVD and Social Touch?. As predicted, germ aversion was positively linked with social touch ($r = .33$, $p < .001$), with the result that participants who scored highly on germ aversion were more inclined to avoid social touch. In spite of an observed positive correlation between perceived infectability and social touch, this was low in magnitude and failed to reach significance ($r = .09$, *ns*). The two perceived vulnerability scales were reliably correlated ($r = .20$, $p < .01$).

Table 1. Correlations Between the Different Variables.

	E	A	C	N	O
GA	−.08	−.12†	.09	.14*	−.09
PI	.03	−.10	−.08	.28***	−.03
STQ	−.36***	−.24***	.05	.28***	−.21**
E		−.01	.03	−.29***	.21**
A			.04	−.23**	.03
C				−.14*	.02
N					−.16*

Note. GA = germ aversion, PI = perceived infectability; STQ = social touch questionnaire; E = extraversion, A = agreeableness, C = conscientiousness, N = neuroticism, O = openness.
* $p < .05$, ** $p < .01$, *** $p < 001$, †: $p < .10$.

What Are the Relationships Between PVD and Social Touch Taking Into Account Personality Traits?. Pearson correlations are shown in Table 1.

The correlations between the two PVD subscales and personality traits were generally low in magnitude, and only the correlations with neuroticism were significant: The participants who were the more averse to germs, and whose perceived infectability was high, scored more highly on the neuroticism personality trait. The correlation between germ aversion and agreeableness was marginally significant, with more germ aversion being associated with lower scores on this personality trait.

Even though the correlations between germ aversion and the five personality traits were low in magnitude, the pattern found here is in line with the results of the recent meta-analysis performed by Oosterhoff et al. (2018). Indeed, these authors reported that the highest correlation with germ aversion was observed for neuroticism, followed by openness. The estimated correlations reported by Oosterhoff et al. (2018) were also of the same sign as those found in the present study, with no significant differences found from the reported values when Fisher's z-Tests on correlations were used. With the exception of conscientiousness, the correlations between the personality traits and social touch avoidance were all significant and relatively high. More precisely, higher levels of extraversion, agreeableness and openness were found in participants who exhibited lower social touch avoidance scores, whereas the opposite was true for participants exhibiting high levels of neuroticism.

Finally and interestingly, when personality traits were controlled for, the correlation between germ aversion and social touch was still significant ($pr(193) = .277$, $p < .001$). The correlation between perceived infectability and social touch was still not significant ($pr(193) = .051$, $p > .1$).

To summarize, in line with the primary aim of Study 1, we found a link between disease avoidance (as indexed by the germ aversion subscale) and social touch, which remained significant when personality traits were taken into account.

Study 2. Social Touch, Vulnerability to Disease, and Personality Traits DURING the COVID-19 Pandemic

Perceived pathogen threat varies among individuals (as revealed for instance by the PVD questionnaire). However, this type of threat can be accentuated by specific situations such as a pandemic. At the time of data collection, the World was witnessing a pandemic caused by a novel virus, SARS-CoV-2, which causes the disease known as COVID-19. Thus, unlike most previous studies, which have focused on "hypothetical" pathogen threats, one strength of Study 2 is that we report people's psychological responses to an actual threat (for previous studies on the impact of a real pathogen threat see, for example: Blakey and Abramowitz, 2017; Blakey et al., 2015; Schaller et al., 2017).

Critically, our study makes it possible to test further a key tenet of the BIS according to which pathogen avoidance attunes people to increasing pathogen threat. In Study 2, the relationships between PVD, social touch, and personality traits were examined during an actual pandemic period. Data collection took place on March 18 and 19, 2020, in France. For reference, the World Health Organization declared COVID-19 a pandemic on March 11, and the data were collected during the first official quarantine in France, which took place in 2020 from March 17 until May 11.

Method

Participants. As in Study 1, the participants were recruited online through the same social media platform (i.e., Facebook). The participants were told that only those who had been previously involved in Study 1 were invited to participate in Study 2 (we used the same experiment identifier). The study took place on March 18 and 19, 2020, a period which, as said above, corresponds to the first official quarantine in France (from March 17 until May 11). We were able to check whether any given participant who had taken part in Study 2 was truly involved in Study 1 because when they took part in Study 1, the student participants had the choice of providing their names in order to earn course credits. Importantly, in both studies, the participants were informed that their identity would be removed later (when running the statistical analyses). From the initial pool of 200 adults, 61 participants took part in Study 2. (There were eleven participants who took part in Study 2 but were not involved in Study 1. Their data were removed from the analyses.)

Questionnaires and Procedure. We used exactly the same questionnaires as those used in Study 1, and we followed exactly the same procedure as described in Study 1. The participants were told that the different surveys were the same when as they first took part but that it was important to answer all the questions spontaneously even though the questions had been answered before.

Table 2. Means (and Standard Deviations) Corresponding to Germ Aversion, Perceived Infectability and Social Touch Questionnaire Scores Before and During the COVID-19 Pandemic.

	Before the pandemic	During the pandemic	t	*p*	d_z
GA	4.18 (.96)	4.55 (.99)	$t(60) = -3.67$	< .001	−.47
PI	4.04 (1.62)	3.92 (1.55)	$t(60) = 1.01$	> .1	.13
STQ	1.87 (.64)	2.01 (.62)	$t(60) = -2.54$	< .05	−.32

Note. GA = germ aversion; PI = perceived infectability; STQ = Social Touch Questionnaire. For STQ, high scores mean strong avoidance of social touch.

Results

We ensured that the participants who completed the questionnaires both before and during the COVID-19 pandemic were comparable to those who were involved in the prepandemic period only. The detailed statistics computed from the two subsamples are available in the Supplementary Material. Turning to the scores given for each scale during the pre- and pandemic period, the correlations were all above .7, except for germ aversion, which just failed to reach this threshold ($r = .68$, $p < .001$). The different measures were thus highly consistent between the two periods.

Has the Pandemic Increased Negative Attitudes Towards PVD, Social Touch, and Their Relationship?. As reported in Table 2, as far as germ aversion is concerned, the mean score was lower before than during the pandemic. The same was true as far as social touch is concerned.

The correlations between germ aversion and social touch were significantly different between the two periods (Dunn & Clark's $z = -2.1$), $p < .05$, and more precisely, they were higher during the pandemic ($r = .45$) than before ($r = .199$), thus suggesting an increase in the positive link between these two dimensions during the coronavirus pandemic.

Has the Pandemic Influenced Personality Traits and Their Relationship with PVD?. As can be seen from Table 3, the mean extraversion score was lower before than during the pandemic. The same trend was found for conscientiousness and openness but only marginally so for both. No reliable differences were observed for agreeableness and neuroticism.

The between-scales—personality traits and disease avoidance dimensions—correlations were generally of the same sign across the two periods (Table 3A in the Supplemental Material). The only noticeable exception was the correlation between perceived infectability and agreeableness, for which the difference was significant (Dunn & Clark's $z = -2.50$; $p < .05$, $r(\text{before}) = -.172$; $r(\text{during}) = .103$).

Personality Traits and Their Relationship with Social Touch. The difference in the correlation between social touch and neuroticism was marginally significant (Dunn & Clark's $z = 1.78$, $p < .1$; $r(\text{before}) =$

Table 3. Means (and Standard Deviations) Corresponding to Personality Traits Before and During the COVID-19 Pandemic.

	Before the pandemic	During the pandemic	t	*p*	d_z
E	2.87 (.90)	2.99 (.87)	$t(60) = -2.27$	< .05	−.29
A	3.90 (.67)	3.95 (.67)	$t(60) = -.88$	> .1	−.11
C	3.58 (.74)	3.67 (.68)	$t(60) = -1.89$	< .1	−.24
N	3.65 (.82)	3.56 (.86)	$t(60) = 1.49$	> .1	.19
O	3.46 (.74)	3.56 (.68)	$t(60) = -1.69$	< .1	−.22

Note. E = extraversion, A = agreeableness, C = conscientiousness, N = neuroticism, O = openness.

.44, r(during) = .27). These differences indicate a reduction in the associations between these variables during the coronavirus pandemic. No other differences between the two periods reached significance (Table 3A in the Supplemental Material).

When personality traits were controlled for, the correlation between germ aversion and social touch was still significant during the coronavirus pandemic ($pr(54) = .481$, $p < .001$)[3].

Discussion of Study 2

In line with the BIS view, we predicted—and found—that a highly salient society-wide pathogen threat should lead to more negative attitudes towards physical contacts and to a higher PVD (and, more precisely, to a higher germ aversion). In line with this latter finding, Makhanova and Shepherd (2020) showed in a study of American participants that higher perceived COVID-19 threat was related to higher PVD scores. Importantly, the positive correlation between social touch and PVD as indexed by germ aversion was stronger during the pandemic than before, suggesting that people who are germ-averse are even more reluctant to engage in social touch during an acute pandemic.

We also predicted that people would become less extraverted during the coronavirus pandemic than before, but this prediction was not borne out. Instead, just the contrary was true. Turning to other personality traits, we found, but only marginally so, that both conscientiousness and openness scores increased during the pandemic. It is interesting to note that, at the time our paper was being written, we become aware of a recent study that also assessed changes in personality traits during the acute phase of the coronavirus pandemic (Sutin et al., 2020). Sutin et al. (2020) hypothesized that "given the extraordinary nature of the coronavirus pandemic, and the drastic measures that have been taken to control its spread, however, personality may be reactive to these rapidly changing events." (p. 2). They tested the preregistered hypotheses that (1) Neuroticisim would increase between the pre- and pandemic period because of the increasing collective anxiety over COVID-19; (2) Conscientiousness would also be higher during the pandemic than before because of public health messaging urging to be cautious in order to control the spread of the virus (e.g., social distancing, wearing a mask). However, they found only modest change in personality traits similar to those found in the present study. They did not find an increase in neuroticism, but instead, a small decline as we have described. Unlike these authors, we found an increase in conscientiousness, but only marginally. Surprisingly, we found that extraversion increased during the coronavirus pandemic (see also Sutin et al., 2020). This finding is at odds with the study by Mortensen et al (2010) which found that exposure to a disease prime led participants to perceive themselves as less extraverted than did exposure to a control prime. It is important to stress that, although there is evidence of a change in certain personality traits during the time of the pandemic coronavirus, the magnitude of the changes is small and acts in directions that are difficult to interpret.

General Discussion

People often serve as vectors of pathogen transmission (Makhanova et al., in press). For instance, viruses or bacteria can be transmitted via physical contacts such as touching someone else's hands or by touching one's own mouth and/or nose after having touched a contaminated surface (e.g., Hewitt et al., 2012; Mela and Whitworth, 2014). We therefore have to be careful in the way we interact with other individuals, that is to say the degree of intimacy with which we engage in social relations, the number of personal contacts, etc., and needless to say, especially during an acute outbreak. Thanks to the BIS, individuals are equipped with an alarm device—disgust—an emotion which helps them reduce or avoid health-threatening contacts with potential harmful people (e.g., people sneezing, coughing) (Ackerman et al., 2018; Schaller, 2006, 2011, 2016; Schaller and Park, 2011). The BIS is therefore a first line of defense against pathogens.[4] The activation of the BIS is subject to individual differences, with some people being more afraid of exposure to germs and becoming sick than others (Duncan et al., 2009; Makhanova et al., 2021). Also, certain situations (e.g., someone coughing next to you on a train) activate the motivation to avoid pathogens more strongly (Makhanova et al., 2020). We investigated one specific link that had not as yet been empirically tested, namely that people who are the more disease-avoidant are also more likely to engage in fewer social behaviors involving touch. Moreover, given the COVID-19 pandemic that the World was facing during 2020 and still is today, we were especially interested in examining whether the pandemic increased negative attitudes towards PVD, social touch, and their relationship. A secondary aim was to examine the interplay between personality traits, disease avoidance and social touch before and during the COVID-19 pandemic. One strength of the present work is that we tested the effects of the activation of the BIS on social touch and personality traits in the context of a real threat, namely a pandemic.

Social Touch and PVD (Before and During the Pandemic)

We found a reliable correlation between "PVDs" as indexed by germ aversion and social touch, with the result that the more germ-averse the participants were, the more they avoided social touch. To our knowledge, this is the first time that this finding has been reported and it provides further evidence for the BIS, whose ultimate function is to reduce or avoid contact with sources of pathogens. (Interestingly, the positive association between germ aversion and social touch avoidance remains when personality dimensions as indexed by the BIG-5 are controlled for.) This finding is in line with the study by Park's (2015) which found that individual differences in pathogen-disgust were correlated with personal space: Adults high in pathogen-disgust sensitivity preferred a larger personal space than those who were lower on this dimension (see also Blacker and LoBue, 2016).

According to the conceptualization of the BIS, a highly salient society-wide pathogen threat, here the COVID-19 pandemic, should lead individuals to be more wary of touching or being touched by other people and to exhibit a higher PVD (as found by Makhanova and Shepherd, 2020 in the United States; see also the Stevenson et al., 2021 study, which found that core disgust sensitivity increased in the "pandemic students" during Australia's COVID-19 pandemic self-quarantine (in March-April 2020) compared with earlier similar samples of students from Macquarie University). Indeed, we found that negative attitudes toward physical contacts, as well as PVD, increased during the pandemic. Also, and importantly, the correlation between germ aversion and social touch was reliably of greater magnitude than during the prepandemic period. Our study therefore validates a key tenet of the BIS, namely that pathogen avoidance attunes people to increasing pathogen threat. Our findings also echo other findings in the literature showing that actual pathogen threat influences other social behaviors, for instance in the domain of politics. Likewise, the Ebola outbreak in 2014 influenced the U.S. federal elections by increasing support for conservative political parties (Schaller et al., 2017). Similar findings have been observed recently in relation to the COVID-19 pandemic (Karwowski et al., 2020). Karwowski et al. (2020) have shown that when COVID-19 posed a considerable threat of disease, both American and Polish people were more likely to promote social conservatism and support conservative political candidates. Indeed, conservative politicians are more prone to endorse decisions that result in the "avoidance of foreigners (outgroup members)." One account is that outgroup individuals historically might have been carriers of some previously unencountered pathogen (e.g., Makhanova et al., 2015, for further discussion see van Leeuwen and Petersen, 2018 and Bressan, 2021); another is that they possibly do not follow customs that might have been adopted to minimize the risk of spreading disease (Karinen et al., 2019; Schaller, 2016). In both cases, the idea is that outgroup members put the in-group at risk of pathogen transmission (Schaller, 2016). As a final example, in the sexual domain where touching behaviors are obviously exhibited, a recent study has shown that reminders of the disease threat of COVID-19 led individuals to express less favorable attitudes and inclinations toward sexual promiscuity (Moran et al., in press).

Even though our findings are compatible with the BIS, we subscribe to Ackerman et al.'s (2021) claim that one must be cautious "when applying insights from the pathogen-avoidance literature to aid understanding of responses to pandemics such as COVID-19" (p. 184), because there are traits related to the COVID-19 pandemic that are specific and novel. Future work on the COVID-19 pandemic will certainly force researchers to reframe their thinking of the mechanisms involved in pathogen-avoidance. But, as also set out by Ackerman et al. (2021): "(…) this caution need not preclude researchers from addressing the interplay between relevant mechanisms and contexts." (p. 184)

Our studies have shown that germ aversion, not perceived infectability, was related to the propensity to engage in social touch. Indeed, perceived infectability and germ aversion were not highly correlated in the present studies. This is in line with Makhanova and Shepherd's (2020) findings ($r = .19$) and suggests that they are two independent factors (Makhanova and Shepherd, 2020; see also Brown et al., 2019a; Díaz et al., 2016). According to Makhanova et al. (in press), germ aversion is similar to disgust sensitivity and is more related to affective-behavioral processes. In contrast, perceived infectability, more than germ aversion, is related to cognitive processes (Díaz et al., 2016; Makhanova et al., in press, e.g., attention to pathogen threats). Thus, individuals with high germ aversion scores should also be more easily disgusted by pathogens, leading them to avoid social touch as far as possible since touch is a vector of transmission for many pathogens (e.g., the SARS-CoV-2) (see Stevenson et al., 2021 who found that greater disgust sensitivity (DS-R) was positively related to higher germ aversion as indexed by the PVD).

Personality Traits and Their Relationship With Disease Avoidance

As far as personality traits are concerned, the findings are generally consistent with previous findings that have shown that certain personality traits are linked with disease avoidance (Oosterhoff et al., 2018). In their meta-analysis, Oosterhoff et al. (2018) reported that greater neuroticism and conscientiousness were associated with greater disease avoidance, while the opposite was true for openness to experience and extraversion. The main findings in our studies involving personality traits were the following. In Study 1, we found, like Oosterhoff et al. (2018), that individuals who were more disease-avoidant scored higher on neuroticism. As far as conscientiousness, but also openness to experience and extraversion are concerned, even though their correlations with disease avoidance were of the same signs as the estimated correlations given by Oosterhoff et al. (2018), they all failed to reach significance in Study 1.[5] Finally, neither the significantly higher level of extraversion nor the marginally significant higher level of openness during the pandemic was expected. We also observed that conscientiousness scores increased marginally during the

pandemic and, like Sutin et al. (2020), also found that neuroticism decreased (albeit only at a descriptive level in the present study) during the pandemic.

Limitations and future directions

It is important to acknowledge several limitations of the present studies that may help frame the current findings and generate directions for future work.

First of all, the sample size of Study 2 was much smaller than that of Study 1 and this is a clear limitation when investigating certain correlations which have been found to be weak, for instance the correlation between disease avoidance scores and personality traits (Oosterhoff et al., 2018). More particularly, we did not replicate previous findings showing that when concerns about disease are elevated—chronically or temporarily—individuals respond with decreased affiliation to others by exhibiting less extraversion (e.g., Mortensen et al., 2010; Schaller and Murray, 2008). As reported in the "Discussion of Study 2" section, Mortensen et al. (2010) found that exposure to a disease prime led participants who were primed with disease to perceive themselves as less extraverted compared to those exposed to a control prime. Also, Schaller and Murray (2008) have shown that in regions where the prevalence of infectious disease is high, individuals are more prone to restrictive sociosexual attitudes, to be less extravert, agreeable, and open to experience. In fact, we found just the opposite, namely that extraversion was higher, not lower, during the pandemic period than before (see also Sutin et al., 2020). It cannot be excluded that this effect is spurious due to the sample size in Study 2. Nevertheless, this finding is intriguing, especially in the light of a very recent study suggesting that individuals who contracted COVID-19 were more extravert than participants who did not (Rolón et al., 2021). Also, extraverts are more likely to use social media and to have more Facebook friends than introverts (Amichai-Hamburger and Vinitzky, 2010; Ryan and Xenos, 2011; Wang, 2017). Thus, perhaps extroverted individuals used social networks more frequently during the pandemic than introverts. If future studies confirm the finding that "extraversion kills" in the context of a pandemic—thus, that being extravert is "maladaptive" in such a context—people who are dispositionally highly extraverted should be particularly clearly informed about a potential deleterious relationship between this personality trait and infection proclivity (see also Carvalho et al., 2020; Han, 2021; Nofal et al., 2020).

Second, our participants were mostly female. Given the particularly large sex asymmetry in our samples, the effects reported in our studies could have been mostly driven by females. The question of whether our findings would have been the same or somewhat different in males is an issue that remains to be investigated in future studies with a more balanced sex-ratio. Such a study should make it possible to test for a moderation by sex. It is possible to anticipate sex differences in relation to disease avoidance, social touch and their relationship. First of all, we know from previous studies that there are strong sex differences in disgust sensitivity, with women having consistently higher levels of disgust than men, and more particularly with regard to sexual and pathogen disgust (e.g., Prokop and Jančovičová, 2013; see Al-Shawaf et al., 2018 for a review). Also, women report higher levels of germ aversion and perceived infectibility than men (e.g., Duncan et al., 2009; Makhanova and Shepherd, 2020). Given that disgust sensitivity and germ avoidance are indexes of the activation of the BIS, these findings suggest that the BIS may be more highly activated in women than in men. Moreover, a number of studies have shown that women are less prone to interpersonal contact than men, and more particularly as far as intimate (physical) contact is concerned. For instance, after having met an attractive woman, (straight) men will consent to sexual intercourse after a much shorter time as elapsed than women are (Buss and Schmitt, 1993). Indeed, straight men are more sexually eager than women (Schmitt et al., 2003), and they are also more likely to engage in opportunistic sexual encounters (e.g., Clark and Hatfield, 1989; Hald and Høgh-Olesen, 2010). Prostitution is an exchange of sexual services for money that is relatively indiscriminate and is almost exclusive to men (Buss, 2019). Men tend to overperceive sexual interest in their relationships with women (Bleske and Buss, 2000; Haselton and Buss, 2000). As a result, it has been shown that women engage in more comfortable and intimate interactions with a gay (compared to a straight) man immediately after discovering his sexual orientation (Russell et al., 2018). Finally, across the globe, women have a general preference for greater interpersonal (social and personal) distance than men (Sorokowska et al., 2017).

On the basis of the findings reported above, it is possible to anticipate that the relationship reported here between germ aversion and social touch could be less strong in men than in women. Even though the number of male participants in our studies was small, we took a closer look at our data to seek for differences between men and women concerning PVD, social touch, and their relationship. Using all the pre-pandemic observations ($N = 200$),[6] and contrary to our expectations, we observed a lower correlation between germ aversion and social touch in women ($r = .28$ and $p < .001$) than in men ($r = .46$ and $p < .05$), but the difference between the two correlations was not significant ($z = -.91$, $p > .1$). In addition, the correlations between perceived infectability and social touch were not significant for the two genders. However, in line with the studies outlined above, we found that the germ aversion scores of women were significantly higher than those of men ($M = 4.09$ vs. $M = 3.45$, $t(198) = 2.82$, $p < .01$, $d = .62$) and also observed higher social touch avoidance scores for women than for men ($M = 1.93$ vs. $M = 1.55$, $t(198) = 2.91$, $p < .01$, $d = .68$).[7]

Third, the great majority of participants were young adults. In future studies, it would be interesting to explore whether the pattern of findings reported here is found in elders since they tend to be more prone to diseases (Mouton et al., 2001). Interestingly, a recent study using the PVD scale on a sample of young (18–21 years) and older adults (Ewald, 2020) revealed that germ aversion increased with age in both men and women.

As far as perceived infectability is concerned, this did not vary with age in men, whereas in women it decreased up to the age of 50 and then increased. According to Díaz et al. (2020), this pattern of findings suggests that the reduced effectiveness of the (reactive) biological immune system with age could be compensated for by the affective component of the BIS—as indexed by germ aversion—in both sexes and by the cognitive component of the BIS—as indexed by perceived infectability—in women. Based on this latter study, it is possible to expect older people to be less likely to engage in social touch than younger ones. Our participants were mostly students and future studies should also therefore attempt to recruit participants having a different socioeconomic background.

Fourth, another significant limitation of our findings is that they only demonstrate associational relationships between pathogen-avoidance motivation and social touch. Thus, claims about causality are not warranted. As a result, further studies should be undertaken to explore potential causal mechanisms between the two constructs.

Finally, since we used questionnaires in order to confirm that social touch is related to disease avoidance propensity, the current work should be complemented by the examination of real behaviors in day-to-day situations. To give an example of such a study, it has been found that the historical prevalence of parasites is negatively associated with the amount of physical contacts when physical contacts take the form of greetings and romantic kissing but not when they are related to mortuary rituals (Murray et al., 2017).

Conclusions

The ultimate function of the BIS is to keep potential sources of contaminations at bay and a straightforward prediction that follows from the BIS is that individual differences in disease avoidance and propensity to physical touching should be related. In line with this prediction, we found that individuals who perceived themselves as more vulnerable to disease were also less prone to touching or being touched by others (and this relationship remained significant when personality traits were controlled for). Moreover, during the COVID-19 pandemic, we found that the association between these two dimensions was strengthened.

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Supplemental material

Supplemental material for this article is available online.

Notes

1. Indeed, humans are not able to assess pathogen threat directly: They likely developed heuristics that detect cues which correlate with infection risks (Kurzban and Leary, 2001; Park et al., 2003; Tybur et al., 2013). The BIS can be compared with a smoke detector (Nesse, 2005). It was designed to reduce costly errors such as judging safe an individual who is contaminated. Likewise, the BIS responds to cues that resemble disease (e.g., birthmarks) but are not related to disease (Kurzban and Leary, 2001; Park et al., 2013; Ryan et al., 2012), or to chronic diseases that do not pose infection risks (e.g., cancer: Azlan et al., 2020).
2. Contextually induced pathogen-avoidance motives (e.g., the COVID-19 pandemic) also relate to more conservatism (Karwowski et al., 2020).
3. Despite a positive observed value of .2, the correlation between germ aversion and social touch was not significant before the pandemic, as was also the case for the corresponding partial correlation, $pr(54) = .114$, $p > .1$
4. Although there are still some theoretical issues surrounding the framing of the BIS (Lieberman and Patrick, 2018; Lieberman et al., 2018; Murray and Schaller, 2016), it should not be conceptualized as separate from the biological immune system. Indeed, several studies have shown that there are functional links between the two immune systems (e.g., Gassen and Hill, 2019; Miller and Maner, 2011; Schaller et al., 2010; Stevenson et al., 2012).
5. We acknowledge that because of the relatively modest correlations found between these dimensions as suggested by Oosterhoff et al.'s (2018) meta-analysis and the sizes of the samples we used, the consistency of their results with ours lies more at a descriptive than at an inferential statistical level (see Figure 1A in the Supplemental Material for information about 90% confidence intervals for the correlations between germ aversion and personality traits in our studies and in Oosterhoff et al.'s (2018) meta-analysis).
6. Given that only five men took part during the pandemic, gender differences were not analyzed.
7. It is worthy of note that neuroticism was higher for women than for men ($M = 3.70$ vs. $M = 2.73$, $t(198) = 5.85$, $p < .001$), but as far as the other scales are concerned, the gender differences were all not significant.

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