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Visual Darkness Reduces Perceived Risk of Contagious-Disease Transmission From Interpersonal Interaction

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Abstract

We examined the psychological impact of visual darkness on people's perceived risk of contagious-disease transmission. We posited that darkness triggers an abstract construal level and increases perceived social distance from others, rendering threats from others to seem less relevant to the self. We found that participants staying in a dimly lit room (Studies 1 and 3–5) or wearing sunglasses (Study 2) tended to estimate a lower risk of catching contagious diseases from others than did those staying in a brightly lit room or wearing clear glasses. The effect persisted in both laboratory (Studies 1–4) and real-life settings (Study 5). The effect arises because visual darkness elevates perceived social distance from the contagion (Study 3) and is attenuated among abstract (vs. concrete) thinkers (Study 4). These findings delineate a systematic, unconscious influence of visual darkness—a subtle yet pervasive situational factor—on perceived risk of contagion. Theoretical contributions and policy implications are discussed.

Keywords
visual darkness, disease risk perception, construal level, social distance, open data, open materials, preregistered

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It is a common observation that crowded places such as movie theaters and bars often have poor illumination. Because the presence of other people in close proximity significantly increases the chance of spreading contagious diseases, we asked the question whether visual darkness might somehow lessen people's nervousness about the risk of contagion in social interactions.

Multiple theories in health behaviors (e.g., health-belief model, Janz & Becker, 1984; theory of reasoned action, Ajzen & Fishbein, 1980; theory of planned behavior, Ajzen, 1991) converge in suggesting that people who perceive themselves at lower risk of catching contagious diseases are likely to attempt riskier behaviors and take fewer protective measures, which increases actual risk of contagion. The relationship between risk perception and behavior was supported in a recent meta-analysis (Brewer et al., 2007). To understand perceived risk of contagious-disease transmission, extant research has primarily relied on individual differences in variables such as general health conditions, knowledge about the disease (Meischke et al., 2000), and belief about susceptibility to infectious diseases (Duncan, Schaller, & Park, 2009). We extended this research stream by investigating the potential influence of visual darkness on people's perceived risk of disease contagion. This is important not only because ambient light is a ubiquitous environmental factor in everyday life but also because countries that are most inflicted by epidemics often have poor infrastructures and unreliable lighting. If visual darkness impacts perceived risk of contagion, then improving illumination in developing worlds might be a pressing task in the fight against epidemics.

Visual Darkness and Risk Perception

Extant research documents that visual darkness can affect a variety of psychological outcomes. For example,

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visual darkness has been shown to reduce intensity of emotional response (Xu & Labroo, 2014), cause a feeling of hopelessness about one's future career prospects (Dong, Huang, & Zhong, 2015), and promote unethical behaviors (Zhong, Bohns, & Gino, 2010). More importantly, darkness could trigger a global conceptual-processing style and is associated with high-level (vs. low-level) construal (Steidle, Werth, & Hanke, 2011). This is because people can see only global features (e.g., a figure of a person) in a dark environment but not details (e.g., the person's face), leading to abstract and global representations in darker settings.

We argue that the elevated construal level as a consequence of ambient darkness could skew estimation of contagion probability when people are confronted, at close range, with potential sources of contagious diseases. According to previous research, a key correlate of construal level is the psychological distance of the event from the person's current state. Research has identified four dimensions of psychological distance, namely, social (self vs. other), spatial (here vs. there), temporal (now vs. future), and hypothetical (likely vs. unlikely). It has been shown that when people operate at a lower construal level, events tend to be perceived as socially close, physically proximate, temporally near, and probabilistically likely (Fujita, Trope, Liberman, & Levin-Sagi, 2006; Liberman & Trope, 1998; Trope & Liberman, 2010). Among the four dimensions, both social distance and probability distance were of particular relevance to the current investigation, whereas physical distance and temporal distance were relatively invariable because we investigated people's current fear of contagion in close face-to-face encounters.

Construal level might directly impact probabilistic estimations. Wakslak and Trope (2009), for example, have induced construal levels in a variety of ways and have consistently shown that people tend to report lower probability for random events when in higher (vs. lower) levels of construal. This suggests that ambient darkness might lead to estimation of lower probabilities, making people think that events are less likely to happen, including catching contagious diseases. However, the existing research has examined probability estimation of only random events (e.g., the probability that a random person might engage in a certain activity), and it is unclear whether construal level could change people's probability estimation regarding things that might happen to themselves. This is important because when it comes to estimating probability of one's own future, there is an optimism bias that tends to lead people to think that misfortunes that happen to others are less likely to happen to themselves (Harris, Griffin, & Murray, 2008; Weinstein, 1980). It is possible that any role of ambient lighting in the estimation of contagion risks through probability distance might be overridden by the optimism bias. Thus, we leave open whether ambient darkness directly deflates probability estimates in general, including contagion risk.

Construal level might also affect perception of contagion risk specifically through social distance. Social distance is the similarity between the self and another person or group (Trope & Liberman, 2010). In-group members and similar individuals are perceived to be socially closer than people belonging to different groups or dissimilar individuals (Liviatan, Trope, & Liberman, 2008). Researchers found that close social distance can curb optimism bias (Alicke, Klotz, Breitenbecher, Yurak, & Vredenburg, 1995; Harris, Middleton, & Joiner, 2000; Perloff & Fetzer, 1986). In general, people believe that they are less likely to be inflicted with the same suffering that others have (Weinstein, 1980), except when compared with socially close others (Alicke et al., 1995; Harris et al., 2000; Perloff & Fetzer, 1986). The socially closer the target, the more people feel at risk of suffering the same negative events as the target. For instance, participants believed that they were less likely to suffer negative events (e.g., "have a heart attack," "get an alcohol problem") compared with out-group members (i.e., the classic optimism bias) but believed that they were equally likely to suffer negative events compared with their in-group members (Harris et al., 2000). This might be related to a general perception of common fate with people who are similar to us, as people find the fate of a similar other more personally threatening than that of a dissimilar other. Drawing on these findings, we expected that people in dark environments might think that they are less likely to catch contagious diseases from a proximate source (e.g., coughing and sniffing) compared with those in well-lit environments, because darkness elevates people's construal level (Steidle et al., 2011), which in turn increases the perceived social distance from the source.

We predicted that ambient darkness would reduce concern for contagious diseases for two different reasons: It might lower the general probability estimate, or it might specifically alter perceived contagion risk from a physically proximate source. It is important to note that these two mechanisms can lead to rather different predictions. In the case in which someone is coughing and sniffing nearby, we would expect darkness to lower the probability estimate for not only contagion risk but also risk of noncontagious diseases (e.g., cancer), on the basis of the former mechanism, whereas the latter mechanism would predict that darkness should lower only contagious risk. We report five studies that tested these predictions.

Study 1: Darkness Reduces Perceived Risk of Disease Contagion

Method

In determining sample size, we used the heuristic of having 50 participants per cell in all lab studies except Study 3 (a preregistered study conducted after the other four studies; thus, sample size was calculated on the basis of the effect sizes observed from the other studies). The final number may vary slightly because of signups and attendance, but we never looked at results before terminating data collection.

Study 1 included 102 undergraduates (83 women, 19 men; age: *M* = 18.90 years, *SD* = 1.23), who participated in exchange for course credit. In this study, we investigated the question, can visual darkness affect participants' perceived risk of disease contagion? Each participant was randomly assigned to one of two between-subjects conditions (staying in a dark room vs. staying in a bright room). A confederate simulated a real-life experience by coughing and sniffing three times (two coughs and one sniff each time) before participants were asked to estimate the likelihood that they would catch a contagious disease (i.e., seasonal flu). In all the studies, both the experimenter and the confederate were blind to our hypotheses.

To test the effectiveness of the darkness and coughing manipulations as well as the setup of the laboratory, we conducted a pilot study before conducting the main study (see Part 1 of the Supplemental Material available online). We manipulated ambient darkness prior to participants' arrival by varying the lighting of the lab. In the bright-room condition, we kept on all the lights (six ceiling tubes), whereas in the dark-room condition, we turned all the lights off. For each session, the confederate reported to the experimenter together with all the other participants.

After arriving at the lab and signing a consent form, each participant was assigned a computer cubicle adjacent to the confederate (at most, 2 participants were run per experimental session; see Part 1 of the Supplemental Material for how we decided to use this layout and Part 3 of the Supplemental Material for a photo of the lab layout). We ensured that the dark room did not appear unusual by informing participants that they were taking part in a documentary evaluation study in which they would watch and evaluate a neutral documentary clip (i.e., "The Internet of Things"). Participants in the dark-room condition were further informed that "we have turned all the lights off while you watch," whereas those in the bright-room condition were told that "we will keep all the lights on while you watch." After watching the documentary clip, participants evaluated it along four dimensions—to what extent they found the documentary clip interesting (1 = *very boring*, 9 = *very interesting*), informative (1 = *not informative at all*, 9 = *very informative*), enjoyable (1 = *I did not enjoy watching it*, 9 = *I enjoyed watching it very much*), and of high quality (1 = *very low quality*, 9 = *very high quality*).

Then, participants proceeded to another ostensibly unrelated "judgment study" allegedly conducted for a different researcher who was interested in understanding how people perceive risks in their daily lives. Participants were then asked to estimate the risk of them getting six different types of diseases (i.e., seasonal flu, skin cancer, diabetes, asthma, hepatitis C, and dementia; a brief definition of each disease was provided to facilitate participants' understanding of the disease). Estimates were made using a round number between 0 (*impossible*) and 100 (*certain to happen*). Before participants estimated the risk of getting diseases, the trained confederate coughed and sniffed three times (two coughs and one sniff each time). Again, on the basis of the argument that darkness increases perceived social distance, we predicted that darkness would lower the perceived risk of getting a contagious disease but not the other noncontagious diseases (because the source showed no sign of those diseases). However, it is also possible that darkness might directly impact the probability estimate and reduce perceived risks in general, regardless of whether they are contagious.

Moreover, it is plausible that darkness may influence people's general risk preference independently of perceived risks of disease. For this reason, we included regulatory-focus and general-risk attitude measures as controls. Specifically, in the third ostensibly unrelated study entitled "About Yourself," participants responded to the Lockwood prevention scale (Lockwood, Jordan, & Kunda, 2002; averaged to provide a composite score of participants' prevention-focus tendency; α = .82) and the risk-aversion scale (Mandrik & Bao, 2005; averaged to provide a composite score of participants' risk-aversion tendency; α = .72). Sample items on the latter scale included "I do not feel comfortable about taking chances," "I avoid situations that have uncertain outcomes," and "I feel nervous when I have to make decisions in uncertain situations"; all items on this scale were rated from 1, *strongly disagree*, to 9, *strongly agree* (for the complete list of items, see Part 4 of the Supplemental Material).

Lastly, participants reported whether they currently had the flu (1 = yes, 2 = no), reported whether they heard other people coughing or sniffing during the study (1 = yes, 2 = no), responded to manipulation-check questions about their perceptions of the lab room (1 = *very dark/cold/dirty*, 9 = *very bright/warm/clean*), and indicated how comfortable, tired, anxious, and relaxed they were when doing the survey (1 = *not at all*, 9 = *very much*) as well as their mood (1 = *sad*, 9 =

happy). They then provided demographic details and were thanked and debriefed using a funnel debriefing (Bargh & Chartrand, 2000).

Results

Manipulation checks. As expected, participants in the dark (vs. bright) room perceived the lab as darker (dark: $M = 2.67$, $SD = 1.99$; bright: $M = 6.49$, $SD = 2.36$), $F(1, 100) = 78.31$, $p < .001$, $\eta^2 = .439$. Participants in the dark room also reported the lab to be colder than did those in the bright room (dark: $M = 5.39$, $SD = 1.51$; bright: $M = 6.57$, $SD = 1.54$), $F(1, 100) = 15.17$, $p < .001$, $\eta^2 = .132$; however, regression analyses revealed that perceived warmth of the room did not significantly affect any participant's risk judgment of getting any of the diseases (ps ≥ .235). Finally, the perceived cleanliness of the room was comparable across the two lighting conditions (dark: $M = 7.78$, $SD = 1.35$; bright: $M = 7.55$, $SD = 1.43$), $F(1, 100) = 0.73$, $p > .250$.

Disease-risk estimation. Because participants' responses may have been biased if they were suffering from the flu at the time of the study, in all five studies, we excluded from further analyses the responses of those who were currently suffering from the flu, leaving a final sample of 94. In Part 2 of the Supplemental Material, we report the results (as robustness checks) after excluding participants who reported that they had not heard anyone coughing or sniffing during the study; the main results remain virtually unchanged if these participants are included.

As expected, we observed a significant main effect of lighting condition on participants' estimation of the possibility of getting the flu, $F(1, 92) = 4.53$, $p = .036$, $\eta^2 = .047$. Participants in the dark room ($M = 42.42$, $SD = 23.72$) estimated a lower risk of getting the flu compared with those in the bright room ($M = 52.73$, $SD = 23.26$), Cohen's $d = 0.44$, 95% confidence interval (CI) for the mean difference = [0.684, 19.941]. No significant differences between the two conditions were obtained regarding the perceived risk of getting the other (noncontagious) diseases (ps > .250; see Table 1). Thus, we averaged participants' risk perceptions of noncontagious diseases to form a composite score. A mixed analysis of variance (ANOVA) with disease type as the within-subjects factor (flu vs. other) and lighting condition as the between-subjects factor yielded a significant Disease Type × Lighting interaction effect, $F(1, 92) = 4.95$, $p = .029$, $\eta^2 = .051$.

In addition, neither participants' prevention focus (dark: $M = 5.82$, $SD = 1.45$; bright: $M = 5.66$, $SD = 1.27$), $p > .250$, nor their general risk aversion (dark: $M = 5.58$, $SD = 1.25$; bright: $M = 5.88$, $SD = 1.15$), $F(1, 92) = 1.46$, $p = .230$, differed across the two conditions. The effect of lighting condition on perceived risk of getting the flu persisted even after we controlled for participants' prevention-focus tendency and general risk aversion, $F(1, 90) = 4.89$, $p = .030$, $\eta^2 = .051$. Ambient darkness also had no effect on either participants' feelings (i.e., how comfortable, tired, anxious, and relaxed they were) while doing the survey or their overall mood (see Table 1).

Table 1. Summary of Results—Study 1 ($N = 94$)

	Dark-room condition	Bright-room condition	Comparison	
Variable	*M* (*SD*)	*M* (*SD*)	*F*(1, 92)	*p*
Perceived risk				
Seasonal flu	42.42 (23.72)	52.73 (23.26)	4.53	.036
Skin cancer	18.56 (15.01)	19.45 (16.58)	0.08	.785
Diabetes	30.22 (21.65)	25.45 (20.76)	1.19	.278
Asthma	21.87 (25.13)	23.69 (23.55)	0.13	.717
Hepatitis C	12.67 (12.16)	13.94 (16.37)	0.18	.672
Dementia	20.42 (20.05)	19.10 (19.28)	0.11	.746
Other measures				
Comfortable	7.18 (1.72)	6.84 (1.94)	0.81	.372
Tired	3.58 (2.74)	4.12 (2.24)	1.12	.293
Anxious	2.24 (1.86)	2.31 (1.65)	0.03	.865
Relaxed	6.62 (1.78)	6.78 (1.70)	0.18	.670
Mood	6.16 (1.43)	6.08 (1.21)	0.07	.786

Discussion

The findings of this study supported our prediction that ambient darkness could reduce people's perceived risk of getting a contagious disease. The other possibility, that darkness would directly influence the probability estimate and reduce perceived risk of all diseases regardless of whether they are contagious, was not supported. Study 2 was intended to test the generalizability of the effect using a different manipulation of darkness.

Study 2: Wearing Sunglasses Reduces Perceived Risk of Disease Contagion

Method

Ninety-six undergraduate students (68 women, 28 men; age: $M = 20.06$ years, $SD = 1.95$) from a large North American university participated for course credit. We employed a one-factor, two-level (sunglasses vs. clear glasses) between-subjects design.

We followed exactly the same procedure of manipulating coughing and sniffing as we did in Study 1. Following Study 1, 2 participants at most were run per session, and they sat adjacent to the confederate's seat (the layout of the lab was identical to that in Study 1). Once seated in the cubicle, and after signing a consent form, participants were informed that the researchers were helping an optical company to test its new products, and they were further told that their evaluation of the glasses would be more accurate after they had worn them for a certain amount of time. Participants were asked to put on a pair of sunglasses (or clear glasses, depending on the condition) and continue wearing them for the duration of the study while filling out an unrelated survey. The unrelated survey was identical to the judgment survey we used in Study 1, except that we also included a five-item perceived anonymity scale (Zhong et al., 2010; α = .67) as an additional control variable because darkness has been shown to increase perceived anonymity (Zhong et al., 2010). This scale was included after the prevention-focus scale (α = .82) and the general-risk-aversion scale (α = .82) but before the glasses-evaluation items (1 = *dislike/negative/unfavorable/low quality/will not buy it*, 9 = *like/positive/favorable/high quality/will buy it*; no significant difference was observed between the sunglasses and the clear glasses; *p*s ≥ .124).

Results

Following our procedure in Study 1, we excluded the responses of 11 participants who reported having caught the flu while the study was running (final *N* = 85). Consistent with the prediction based on construal-level theory and the results of Study 1, participants who wore sunglasses reported a lower possibility of catching the seasonal flu (*M* = 32.05, *SD* = 17.46) than those who wore clear glasses (*M* = 41.98, *SD* = 24.38), Cohen's *d* = 0.47, 95% CI for the mean difference = [0.622, 19.231]. The main effect of darkness on participants' estimation of the possibility of getting the flu was significant, $F(1, 83) = 4.50$, $p = .037$, $\eta^2 = .051$. No significant differences were obtained regarding the perceived risk of getting the other (noncontagious) diseases (*p*s > .250; see Table 2). As in Study 1, we averaged participants' estimation of the likelihood of catching the five noncontagious diseases to form a composite score. A mixed ANOVA with disease type as the within-subjects factor (flu vs. others) and darkness (wearing sunglasses vs. wearing clear glasses) as the independent variable yielded a significant Disease Type × Darkness interaction effect, $F(1, 83) = 4.97$, $p = .029$, $\eta^2 = .056$.

In addition, participants' general risk aversion (sunglasses: *M* = 6.22, *SD* = 1.29; clear glasses: *M* = 5.75, *SD* = 1.50), $F(1, 83) = 2.31$, $p = .133$, did not differ across the two conditions. Replicating the results of Zhong et al. (2010), we also observed that participants who wore sunglasses (*M* = 5.43, *SD* = 0.97) reported feeling more anonymous during the study than those who wore clear glasses (*M* = 4.78, *SD* = 1.21), $F(1, 83) = 7.12$, $p = .009$, $\eta^2 = .079$. However, perceived anonymity did not predict participants' disease-risk estimations (*p*s ≥ .231). Although participants in the sunglasses condition reported a higher prevention focus tendency (*M* = 6.15, *SD* = 1.31) than did those in the clear-glasses condition (*M* = 5.53, *SD* = 1.38), $F(1, 83) = 4.42$, $p = .039$, $\eta^2 = .051$, the effect of darkness on estimation of flu-risk contagion remained viable even after we controlled for participants' general risk aversion, perceived anonymity, and chronic prevention-focus tendency, $F(1, 80) = 3.73$, $p = .057$, $\eta^2 = .045$. Moreover, as in Study 1, no significant difference between the two conditions was observed for other measures, including comfortableness, tiredness, anxiety, relaxation, and mood (see Table 2).

Table 2. Summary of Results—Study 2 (*N* = 85)

	Sunglasses condition	Clear-glasses condition	Comparison	
Variable	*M* (*SD*)	*M* (*SD*)	*F*(1, 83)	*p*
Perceived risk				
Seasonal flu	32.05 (17.46)	41.98 (24.38)	4.50	.037
Skin cancer	16.56 (14.53)	16.09 (17.06)	0.02	.891
Diabetes	19.64 (15.36)	22.50 (23.98)	0.41	.523
Asthma	16.51 (18.16)	18.67 (25.89)	0.19	.663
Hepatitis C	10.03 (13.47)	8.57 (12.98)	0.26	.613
Dementia	11.18 (14.83)	11.35 (13.72)	0.00	.957
Other measures				
Comfortable	7.15 (1.41)	6.67 (1.51)	2.28	.135
Tired	4.08 (2.42)	4.22 (2.22)	0.08	.781
Anxious	3.23 (1.88)	2.67 (1.58)	2.20	.142
Relaxed	6.18 (1.99)	6.17 (1.99)	0.00	.990
Mood	5.67 (1.24)	5.41 (1.09)	1.01	.318

Discussion

The results of this study further supported the hypothesis that visual darkness leads people to estimate a lower risk of catching a contagious disease. Study 3 was designed to replicate the findings of Studies 1 and 2 and to directly measure and test the potential mediating role of perceived social distance underlying the effect we observed.

Study 3: Perceived Social Distance Mediates the Effect of Ambient Darkness on Lowered Contagious Disease Risk Perception

Method

We preregistered the hypotheses, detailed measures and procedures, and the data-analysis plan for Study 3 via the Open Science Framework (https://osf.io/h489p/). To ensure a well-powered replication study, we estimated the sample size by calculating the number of participants required to test a directional hypothesis regarding a difference between two independent groups under the following conditions: $\alpha = .05$, $d = 0.44$ (on the basis of the Study 1 results; a medium effect size; Cohen, 1988), and power = .90. Thus, the required sample size was 180. The sample size was nearly twice as large as that for Study 1 ($N = 102$), and the power of the sample-size estimation (.90) was greater than that for Study 1 (.56).

We recruited 198 undergraduate students (119 women, 79 men; age: $M = 19.74$ years, $SD = 2.21$) to ensure that we had enough participants for the replication study. They participated in this study for course credit. Each participant was randomly assigned to one of two conditions (dark room vs. bright room) of a single-factor between-subjects design.

We followed exactly the same procedure to manipulate coughing and sniffing as we did in Studies 1 and 2. Unlike in Studies 1 and 2, in which 1 or 2 participants were run per session, each experimental session in Study 3 consisted of the same number of individuals (i.e., 2 participants and one confederate), so that we could measure each participant's perceived social distance from the confederate and the other participant present in the room while keeping the spatial distance between each of them constant. The 2 participants sat adjacent to the confederate's seat, similar to the first two studies (the layout of the lab was identical to that in Study 1; see Part 3 of the Supplemental Material). Once seated in the cubicle, and after signing a consent form, participants were first asked to evaluate a neutral documentary as part of the cover story for the darkness manipulation, following exactly the same procedure as we used in Study 1. Then all participants proceeded to the judgment survey that we used in Study 1, except that we also included a seven-item social distance measure (adapted from Zhang & Wang, 2009; see Part 5 of the Supplemental Material) after the disease-risk estimation. Each participant answered the same set of social distance questions twice (once for the confederate and once for the other participant). We conducted a pretest to verify the validity of the social distance measure (i.e., the proposed mediator) before conducting the main Study 3 (for details of the pretest, see Part 5 of the Supplemental Material). Moreover, we omitted the two control variables (prevention-focus tendency and general risk aversion) included in Studies 1 and 2 because these two variables did not account for any variance in risk estimation in the first two studies.

Results

Manipulation checks. As expected, participants in the dark (vs. bright) room perceived the lab as darker (dark: $M = 1.79$, $SD = 1.37$; bright: $M = 7.32$, $SD = 1.45$), $F(1, 196) = 756.21$, $p < .001$, $\eta^2 = .794$. As in Study 1, participants in the dark room also reported the lab to be colder than did those in the bright room (dark: $M = 4.66$, $SD = 1.33$; bright: $M = 5.23$, $SD = 1.70$), $F(1, 196) = 7.03$, $p = .009$, $\eta^2 = .035$; however, regression analyses revealed that perceived warmth of the room did not significantly affect any participant's risk judgment of getting any of the diseases ($ps \geq .089$). Finally, the perceived cleanliness of the room was comparable across the two lighting conditions (dark: $M = 6.52$, $SD = 1.61$; bright: $M = 6.60$, $SD = 1.71$), $F(1, 196) = 0.12$, $p > .250$.

Disease-risk estimation. Following Study 1, we excluded 16 participants who reported having caught the flu while the study was running (final $N = 182$). Participants in the dark room reported a lower possibility of catching the seasonal flu ($M = 37.81$, $SD = 26.05$) than did those in the bright room ($M = 51.30$, $SD = 28.41$), Cohen's $d = 0.49$, 95% CI for the mean difference = [5.510, 21.457], consistent with the prediction based on construal-level theory and the results of Studies 1 and 2. The main effect of darkness on participants' estimation of the possibility of getting the flu was significant, $F(1, 180) = 11.13$, $p = .001$, $\eta^2 = .058$. Moreover, we found that participants in the dark room ($M = 14.21$, $SD = 17.06$) also reported a lower possibility of getting hepatitis C than did those in the bright room ($M = 19.64$, $SD = 16.85$), $F(1, 180) = 4.66$, $p = .032$, $\eta^2 = .025$. No significant differences were obtained regarding the perceived risk of getting the other (noncontagious) diseases ($ps \geq .139$; see Table 3). Following the first two studies, we averaged participants' estimation of the likelihood of catching the five noncontagious diseases to form a composite score. A mixed ANOVA with disease type as the within-subjects factor (flu vs. others) and darkness (dark room vs. bright room) as the independent variable yielded a significant Disease Type × Darkness interaction effect, $F(1, 180) = 11.36$, $p = .001$, $\eta^2 = .059$.

In addition, although participants in the dark room felt less comfortable (dark: $M = 6.32$, $SD = 1.98$; bright: $M = 6.84$, $SD = 1.42$), $F(1, 180) = 4.07$, $p = .045$, $\eta^2 = .022$, and also less anxious (dark: $M = 2.32$, $SD = 1.67$; bright: $M = 2.93$, $SD = 1.71$), $F(1, 180) = 6.04$, $p = .015$, $\eta^2 = .032$, than did those in the bright room, the main effect of ambient darkness on the risk estimation of contagious disease (flu) remained significant even after we controlled for the comfortableness and anxiety ratings, $F(1, 178) = 9.65$, $p = .002$, $\eta^2 = .051$.

Mediation analyses. Participants' ratings of perceived social distance from the confederate and the other participant were highly correlated ($r = .86$, $p < .001$), and therefore, we reverse-coded and averaged participants' perceived social distance from the other two people in

Table 3. Summary of Results—Study 3 ($N = 182$)

Variable	Dark-room condition M (SD)	Bright-room condition M (SD)	Comparison F(1, 180)	p
Perceived risk				
Seasonal flu	37.81 (26.05)	51.30 (28.41)	11.13	.001
Skin cancer	16.93 (18.58)	16.89 (16.56)	0.00	.987
Diabetes	27.27 (25.32)	22.37 (18.65)	2.21	.139
Asthma	22.99 (26.62)	22.29 (20.92)	0.04	.843
Hepatitis C	14.21 (17.06)	19.64 (16.85)	4.66	.032
Dementia	21.25 (22.90)	20.21 (17.02)	0.12	.727
Other measures				
Comfortable	6.32 (1.98)	6.84 (1.42)	4.07	.045
Tired	4.32 (2.24)	4.16 (1.97)	0.24	.623
Anxious	2.32 (1.67)	2.93 (1.71)	6.04	.015
Relaxed	6.11 (2.10)	6.36 (1.78)	0.77	.382
Mood	5.80 (1.34)	5.91 (1.42)	0.29	.592

the room (i.e., the confederate and the other participant) to create an index of social distance. To investigate whether visual darkness increases perceived social distance and therefore reduces people's perceived likelihood to catch a contagious disease, we conducted mediation analyses (see Fig. 1). Regression analysis showed that visual darkness (1 = darkness, 0 = brightness) increases perceived social distance, $b = 1.69$, $SE = 0.25$, $t(180) = 6.72$, $p < .001$, and reduces the estimated risk of catching a contagious disease, $b = -13.48$, $SE = 4.04$, $t(180) = -3.34$, $p = .001$. Perceived social distance is negatively related to risk of contagious disease, $b = -5.88$, $SE = 1.02$, $t(180) = -5.79$, $p < .001$. When both ambient darkness and social distance were entered as predictors of risk of contagious disease, the effect of ambient darkness became nonsignificant, $b = -4.47$, $SE = 4.28$, $t(179) = -1.05$, $p > .250$, whereas perceived social distance remained viable, $b = -5.35$, $SE = 1.14$, $t(179) = -4.71$, $p < .001$. Bootstrapping procedures (using 5,000 samples; Hayes, 2013) further confirmed that the indirect effect of ambient darkness on estimated risk of contagious disease was through perceived social distance, 95% CI = [−14.5997, −4.4994]. Note that using participants' social distance from the confederate or their perceived social distance from the other participant separately as the mediator yielded the same conclusion.

Discussion

The results of this study demonstrated the mediating role of perceived social distance in driving the effect. In Study 4, we intended to provide a further test of this mechanism by investigating the moderating role of construal level, on the basis of the moderation-of-process approach (Spencer, Zanna, & Fong, 2005). If darkness reduces perceived contagion risk by increasing perceived social distance from other people, then for people who already have a higher (vs. lower) construal level and therefore perceive greater social distance from others, the darkness effects should be attenuated.

Study 4: Dispositional Construal Level Moderates the Effect of Ambient Darkness on Lowered Perception of Risk of Contagious Diseases

Method

One hundred fourteen undergraduate students (38 women, 53 men, 23 unreported; age: $M = 19.61$ years, $SD = 1.33$) participated in this study for course credit. Each participant was randomly assigned to one of two conditions (dark room vs. bright room) of a single-factor between-subjects design. They participated in groups of 2 to 4.

After arriving at the lab and signing a consent form, participants were instructed that a lighting company invited them to evaluate a new lamp before launching it to the local market. We manipulated ambient brightness prior to participants' arrival. In the dark-room

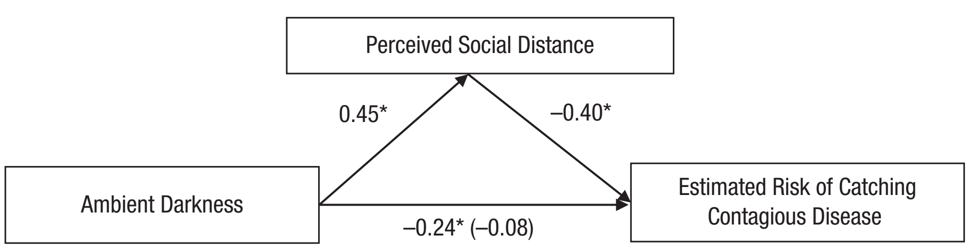

Fig. 1. Mediation model showing the effect of ambient darkness on estimated risk of catching a contagious disease, as mediated by perceived social distance (Study 3). Standardized regression coefficients are reported. Along the bottom path, the value outside parentheses shows the total effect, and the value inside parentheses shows the direct effect after controlling for the mediator. Asterisks indicate significant paths ($p < .01$).

condition, we turned off all the ceiling lights and adjusted the brightness of the lamp to the dimmest. In the bright-room condition, we kept all the ceiling lights on and adjusted the brightness of the lamp to the brightest (the lamp has a nine-level brightness adjustment function; for photos of the room, see Part 6 of the Supplemental Material). We measured the brightness of the rooms using a professional light meter that captures the luminance level of the environment in lux (i.e., the unit of luminance measuring luminous flux per unit area, which equals one lumen per square meter). The measurements revealed that whereas the bright room generated 940 lux, the dim room generated only 120 lux, a noticeable difference to human eyes. Participants were further instructed to treat the lamp as a regular piece of furniture in their home or office and were reminded not to touch or change the setting of the lamp. Participants were then asked to fill out some unrelated surveys in the meantime and were told that they would be asked to evaluate the lamp at the end of the study. Participants completed the same disease-risk estimation as we used in Studies 1 to 3 under this guise. After giving participants instructions, the experimenter coughed and sniffed three times (each time consisting of two coughs and one sniff) at the beginning of the risk-estimation task.

After finishing the risk-estimation task, participants completed the Behavioral Identification Form (BIF; Vallacher & Wegner, 1987), a classic measure of individuals' trait construal level that has been widely used in previous research (e.g., Liberman & Trope, 1998; Vallacher & Wegner, 1987, 1989). Specifically, participants were provided with a list of 25 actions. Each action was described in two alternate identifications including one lower and one higher in construal level, and participants were asked to circle the alternative that best describes the action for them. For example, reading was described as "gaining knowledge" at a high level or "following lines of print" at a low level. Previous research has suggested that the BIF score could capture both individuals' stable trait (e.g., Fujita et al., 2006; Vallacher & Wegner, 1987, 1989) and more transient, situational state in construal level (e.g., Aggarwal & Zhao, 2015). If the BIF captures stable tendencies in people's construal level, we would expect that darkness should reduce perceived risk of contagious diseases only among those with low construal levels; in other words, we would expect the BIF to moderate the relationship between darkness and risk perception. If, however, the BIF captures the situational variation in construal levels, we would expect that darkness should increase construal levels, which would in turn decrease perceived risk of contagious diseases; in other words, in this case, the BIF would mediate the relationship between darkness and risk perception. We tested both possibilities in this study.

Finally, as in our prior studies, participants reported whether they were currently suffering from the flu and whether they had heard other participants coughing or sniffing during the study, and they responded to manipulation-check questions on their feelings about the lab room (1 = *very dark/cold/dirty*, 9 = *very bright/warm/clean*); how comfortable, tired, anxious, and relaxed they felt while doing the survey (1 = *not at all*, 9 = *very much*); and their mood (1 = *sad*, 9 = *happy*). They then provided demographic details and were thanked and debriefed using a funnel debriefing (Bargh & Chartrand, 2000). We did not include measures of prevention focus or general risk aversion because they did not account for any variance in risk estimation in Studies 1 and 2.

Results

Manipulation checks. In one experimental session, the lamp accidentally turned off halfway; thus, the data from the 4 participants in that session were removed from further analysis. As expected, participants staying in the dark room rated the room as darker than did those staying in the bright room (dark: M = 3.40, SD = 1.50; bright: M = 7.44, SD = 1.20), $F(1, 105) = 232.44$, $p < .001$, $\eta^2 = .689$; the smaller degree of freedom was due to three missing values. No significant difference was observed in terms of perceived warmth (dark: M = 5.65, SD = 1.59; bright: M = 5.72, SD = 1.78) and cleanliness (dark: M = 7.16, SD = 1.99; bright: M = 7.06, SD = 1.97) of the room, ps > .250.

Disease-risk estimation. Following the first three studies, we excluded participants who were suffering from the flu during the study from further analyses (final N = 94). We first coded participants' choice of the low-level identification for any item as 0 and their choice of the high-level identification for any item as 1, consistent with prior work (Fujita et al., 2006; Liberman & Trope, 1998). We then summed these item scores to form an index of action-identification level. The possible range for the index is 0 to 25, with higher scores indicating a stronger preference for high-level, more abstract action identification and hence a higher construal level.

We first checked whether our experimental manipulation of darkness affected the BIF score. An ANOVA revealed that participants' construal level captured by the BIF scale did not significantly differ between the two conditions (dark: M = 16.06, SD = 4.09; bright: M = 16.05, SD = 4.43), $F(1, 92) = 0.00$, $p > .250$. This suggests that the BIF measure captured stable trait differences in construal level in our analyses. Thus, we tested the potential moderating effect of construal level

(BIF) on the relationship between visual darkness and perceived risk of catching the flu. Our logic was that if darkness reduces perceived contagion risk by elevating people's construal level and increasing the perceived social distance from others, then for people who already have a higher (vs. lower) construal level, the darkness effects on risk estimation should be attenuated. In other words, if darkness indeed changes disease-risk estimation by elevating construal level, then the effect should hold only for participants with a low construal level.

Specifically, we conducted a regression analysis with flu-risk estimation as the dependent variable, and darkness condition (1 = dark room, −1 = bright room), mean-centered BIF score (measuring construal level), and their interaction as the independent variables. The results yielded a main effect of darkness condition, $b = -5.14$, $SE = 2.20$, $t(90) = -2.34$, $p = .022$, and a significant Darkness Condition × BIF interaction, $b = 1.38$, $SE = 0.52$, $t(90) = 2.65$, $p = .010$**.** Thus, this study replicated the main effect of darkness on reduced risk estimation (dark: $M = 39.43$, $SD = 19.17$; bright: $M = 49.72$, $SD = 24.60$), $F(1, 92) = 5.19$, $p = .025$, $\eta^2 = .053$, Cohen's $d = 0.47$, 95% CI for the mean difference = [1.317, 19.262] (see Table 4). No significant differences were obtained regarding the perceived risk of getting the other (noncontagious) diseases (ps ≥ .060; see Table 4). Following the first three studies, we averaged participants' estimation of the likelihood of catching the five noncontagious diseases to form a composite score. A mixed ANOVA with disease type as the within-subjects factor (flu vs. others) and darkness (dark room vs. bright room) as the independent variable yielded a significant Disease Type × Darkness interaction effect, $F(1, 92) = 8.13$, $p = .005$, $\eta^2 = .081$.

Table 4. Summary of Results—Study 4 (N = 94)

	Dark-room condition	Bright-room condition	Comparison	
Variable	M (SD)	M (SD)	F(1, 92)	p
Perceived risk				
Seasonal flu	39.43 (19.17)	49.72 (24.60)	5.19	.025
Skin cancer	18.36 (18.01)	19.21 (21.19)	0.04	.835
Diabetes	32.02 (23.89)	22.72 (23.14)	3.64	.060
Asthma	18.80 (20.45)	20.88 (27.05)	0.18	.673
Hepatitis C	19.08 (20.55)	15.51 (18.46)	0.77	.382
Dementia	20.39 (23.71)	17.67 (19.91)	0.35	.553
Other measures				
Comfortable	6.88 (1.60)	7.33 (1.25)	2.19	.143
Tired	4.63 (2.41)	4.28 (2.32)	0.50	.479
Anxious	3.35 (2.01)	2.81 (1.74)	1.90	.171
Relaxed	6.10 (1.93)	6.23 (2.00)	0.11	.741
Mood	6.00 (1.44)	6.42 (1.03)	2.53	.115

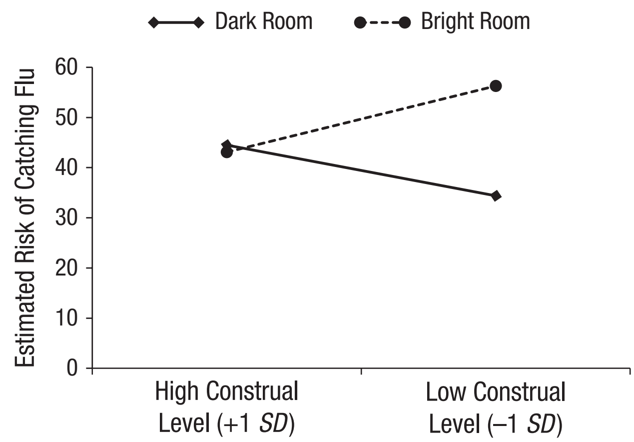

Fig. 2. Mean estimated risk of catching a contagious disease as a function of participants' construal level and whether they were in a dark or bright room (Study 4).

We conducted spotlight analysis (±1 SD; Aiken & West, 1991) with the MODPROBE SPSS macro (Hayes & Matthes, 2009) to further probe the interaction. As expected, the analysis revealed that the effect of darkness condition on flu estimation appeared only for participants with a low construal level (dark: $M = 34.35$, bright: $M = 56.30$), $b = -10.98$, $SE = 3.11$, $t(90) = -3.53$, $p < .001$, 95% CI = [−17.16, −4.79], but not for those with a high construal level (dark: $M = 44.50$, bright: $M = 43.12$), $b = 0.69$, $SE = 3.11$, $t(90) = 0.22$, $p > .250$, 95% CI = [−5.49, 6.87] (see Fig. 2).

Discussion

The results of this study not only replicated the effect of darkness on reduced risk estimation (Studies 1–3) but also revealed that this effect disappears for chronic abstract (vs. concrete) thinkers. By the logic of "moderation of process" (Spencer et al., 2005), this pattern provides further support for the proposed underlying mechanism that darkness reduces perceived contagion risk by elevating construal level and hence perceived social distance among people. Study 5 tested whether the effect would hold in a natural setting.

Study 5: Darkness Influences Risk Perception in a Natural Setting

Method

One hundred seventy-five master of business administration students (37 women, 85 men, 53 unreported; age: $M = 27.57$ years, $SD = 3.53$) from a large North American university participated in the study. The sample size was determined by the size of available classes.

Data collection was conducted in the beginning of each of four classes. We manipulated the darkness of the room prior to students' arrival. For two class sections, we adjusted the brightness of the room to be low using the podium control panel (i.e., the dim-classroom condition). In contrast, we adjusted the brightness of the room to be full for the other two classes (i.e., the bright-classroom condition; for a photo of the classroom, see Part 7 of the Supplemental Material). We took measurements with the light meter for the center seat of each row in the classroom (see Part 8 of the Supplemental Material) and averaged the measurements for the bright and dim conditions separately. The results revealed that, on average, the bright classroom generated 505.4 lux, whereas the dim classroom generated 241.6 lux. All four classrooms were identical in size and setting (all were located in the basement level and, thus, none of them had natural light).

Participants were told that they would take part in a short academic survey about people's perceived risks in their daily lives. We used the same judgment survey as in our previous studies, except that we omitted the prevention-focus scale, the general-risk-attitude scale, and other control measures (e.g., comfortableness, tiredness, anxiety, relaxed feeling, and mood) to keep the survey short; however, we kept manipulation-check items and items measuring whether they were suffering from the flu and whether they heard coughing or sniffing during the survey session. In the beginning of the judgment survey, after giving instructions to participants, the experimenter coughed and sniffed three times.

Results

Manipulation checks. As expected, participants who completed the survey in the dim (M = 5.26, SD = 2.04) classroom perceived the room as darker compared with those in the bright classroom (M = 6.34, SD = 1.52), $F(1, 171) = 15.49$, $p < .001$, $\eta^2 = .083$. No significant differences were observed for perceived warmth (dim: M = 5.69, SD = 1.51; bright: M = 5.31, SD = 1.68), $F(1, 170) = 2.34$, $p = .128$, and cleanliness of the room (dim: M = 6.81, SD = 1.88; bright: M = 6.61, SD = 1.72), $F(1, 170) = 0.50$, $p > .250$. The variation in degrees of freedom resulted from missing values.

Disease-risk estimation. Following our previous studies, we excluded 36 participants who had caught the flu, 1 participant whose estimation exceeded 100, and 10 responses with missing values (final N = 128). Consistent with our prediction and the results of our prior studies, results showed that participants who completed the survey in the dim classroom reported a lower possibility of catching the seasonal flu (M = 33.32, SD = 21.65) than did those in the bright classroom (M = 54.54, SD = 25.18), Cohen's d = 0.90, 95% CI for the mean difference = [13.011, 29.422]. The main effect of darkness on participants' estimation of the possibility of getting the flu was significant, $F(1, 126) = 26.18$, $p < .001$, $\eta^2 = .172$. No significant differences were obtained regarding the perceived risk of getting the other (noncontagious) diseases (ps ≥ .236; see Table 5). Following our prior studies, we averaged participants' estimation of their chance of catching the five noncontagious diseases to form a composite score. A mixed ANOVA with disease type as the within-subjects factor and lighting condition as the between-subjects factor yielded a significant Disease Type × Lighting Condition interaction effect, $F(1, 126) = 17.34$, $p < .001$, $\eta^2 = .121$ (see Table 5). Thus, this study suggests that the effect of darkness on disease perception persists across laboratory and real-life settings.

Discussion

In summary, the findings from the five studies converge to suggest that visual darkness reduces people's risk estimation of disease contagion. Moreover, when these experimental findings were aggregated using a meta-analysis (see Part 9 of the Supplemental Material), this consistent pattern persisted across studies with different manipulations of darkness and across different settings.

General Discussion

Across five studies, we showed that darkness triggers an abstract construal level and increases perceived social distances (Study 3), reducing people's perceived risk of disease contagion. Critically, the darkness effect disappeared for abstract (vs. concrete) thinkers (Study 4). The effect persisted in both laboratory (Studies 1–4) and natural (Study 5) settings. Our studies did not support the alternate prediction that darkness might reduce probability estimates across the board because of a higher construal level increasing probability distance.

Our research contributes to the literature in two important aspects. First, it represents the first attempt to link darkness with a lowered estimation of perceived risk of disease transmission. Many factors are known to influence risk estimation of contagious diseases, including one's own chronic vulnerability to disease (Duncan et al., 2009), perception of unrelated hazards (Johnson & Tversky, 1983), media coverage of a certain type of health risk (Kalichman, 1994). We suggest that ambient darkness—as a subtle environmental factor—can also affect (reduce) one's perceived risk of contagious diseases. Moreover, although perceived vulnerability to disease was not responsive to our darkness manipulation (pretest of Study 3, Part 5 of the

Table 5. Summary of Results—Study 5 (N = 128)

Perceived-risk variable	Dim-classroom condition	Bright-classroom condition	Comparison	
	M (SD)	M (SD)	F(1, 126)	p
Seasonal flu	33.32 (21.65)	54.54 (25.18)	26.18	.000
Skin cancer	17.95 (18.54)	22.17 (21.64)	1.41	.238
Diabetes	23.25 (24.64)	28.56 (25.85)	1.42	.236
Asthma	18.71 (25.47)	23.75 (29.07)	1.09	.298
Hepatitis C	11.28 (12.75)	11.73 (13.01)	0.04	.844
Dementia	24.83 (25.37)	25.59 (24.68)	0.03	.865

Supplemental Material), future research could explore the potential moderating role of one's perceived vulnerability to disease (Duncan et al., 2009) or beliefs about danger (Altemeyer, 1988) in the relationship between ambient darkness and estimated risk of disease contagion.

Second, the present work contributes to the literature on the psychological consequences of darkness by offering a new perspective that environmental factors such as darkness can affect estimated risk of contagious diseases. Previous research mainly focused on how darkness influences ones' personal behaviors, such as promoting self-interest behaviors (Zhong et al., 2010), causing a feeling of hopelessness about one's future career prospects (Dong et al., 2015), and reducing intensity of affective response (Xu & Labroo, 2014). Our research suggests that darkness could also have interpersonal consequences by reducing the perceived risk of catching contagious diseases from other people, which is driven by increased perceived social distance from others.

Additionally, our research has substantial implications for organizations and policymakers by suggesting that improving illumination might be a simple method to nudge employees, especially those working in organizations or public settings where the chance of catching contagious diseases is relatively high (e.g., cinemas, theaters, gymnasiums, stadiums, hospitals, and aircraft), to be more cautious about disease transmission. That said, it is also possible that heightened risk of contagion in more developed countries might contribute to the growing concern of hypochondriacs and antibacterial overuse (Krisch, 2016), so the use of lighting could be a double-edged sword.

Two potential qualifications should be noted. First, even though in our studies, perceived physical distance did not vary between conditions because of the face-to-face setup, future research could relax this constraint and identify situations in which ambient darkness might increase perceived physical distance in addition to social distance from others and test which of them has a greater impact on people's perceived risk of disease contagion.

Second, our findings might seem contradictory to the intuition that out-group members should pose a greater disease threat than in-group members (Navarrete & Fessler, 2006; Suedfeld & Schaller, 2002). However, although it is possible that in- and out-group dynamics may be in part driven by self-protection and disease avoidance (e.g., Neuberg, Kenrick, & Schaller, 2011), it is questionable whether such motives can drive intergroup behaviors that occur in the same social and ecological environment. Further, in our investigation, perceived disease threat was kept constant between the darkness and brightness conditions because participants in both conditions were aware of the fact that they were next to a person who showed signs of the flu. The question was to what extent participants thought they might catch the flu from that person. We drew on previous research on egocentric bias and shared fate to answer this question, and our results are entirely consistent with the existing findings on the classic egocentric bias that, generally, people think that they are less likely to suffer the negative events that others have suffered, except when comparing themselves with in-group members or similar others (Harris et al., 2000). That said, it would be interesting to explore in future research how people estimate risk of disease contagion from in-group (vs. out-group) members.

Action Editor

Bill von Hippel served as action editor for this article.

Author Contributions

The idea for these studies was conceived by P. Dong and C.-B. Zhong. Both authors contributed to the design of each study. Data were collected by research assistants supervised by P. Dong. P. Dong analyzed the data and drafted the manuscript, and C.-B. Zhong provided critical revisions. Both authors approved the final manuscript for submission.

Declaration of Conflicting Interests

The author(s) declared that there were no conflicts of interest with respect to the authorship or the publication of this article.

Supplemental Material

Additional supporting information can be found at http://journals.sagepub.com/doi/suppl/10.1177/0956797617749637

Open Practices

All data and materials have been made publicly available via the Open Science Framework (OSF) and can be accessed at https://osf.io/cwzaj and https://osf.io/d98rv, respectively. The design and analysis plan for Study 3 were preregistered at OSF (https://osf.io/h489p/). Designs and analysis plans of the other studies were not preregistered. The complete Open Practices Disclosure for this article can be found at http://journals.sagepub.com/doi/suppl/10.1177/0956797617749637. This article has received badges for Open Data, Open Materials, and Preregistration. More information about the Open Practices badges can be found at http://www.psychologicalscience.org/publications/badges.

References

Aggarwal, P., & Zhao, M. (2015). Seeing the big picture: The effect of height on the level of construal. *Journal of Marketing Research*, *52*, 120–133.

Aiken, L. S., & West, S. G. (1991). *Multiple regression: Testing and interpreting interactions*. Newbury Park, CA: SAGE.

Ajzen, I. (1991). The theory of planned behavior. *Organizational Behavior and Human Decision Processes*, *50*, 179–211.

Ajzen, I., & Fishbein, M. (1980). *Understanding attitudes and predicting social behavior*. Englewood Cliffs, NJ: Prentice Hall.

Alicke, M. D., Klotz, M. L., Breitenbecher, D. L., Yurak, T. J., & Vredenburg, D. S. (1995). Personal contact, individuation, and the better-than-average effect. *Journal of Personality and Social Psychology*, *68*, 804–825.

Altemeyer, B. (1988). *Enemies of freedom: Understanding right-wing authoritarianism*. San Francisco, CA: Jossey-Bass/Pfeiffer.

Bargh, J. A., & Chartrand, T. L. (2000). The mind in the middle: A practical guide to priming and automaticity research. In H. T. Reis & C. M. Judd (Eds.), *Handbook of research methods in social and personality psychology* (pp. 253–285). New York, NY: Cambridge University Press.

Brewer, N. T., Chapman, G. B., Gibbons, F. X., Gerrard, M., McCaul, K. D., & Weinstein, N. D. (2007). Meta-analysis of the relationship between risk perception and health behavior: The example of vaccination. *Health Psychology*, *26*, 136–145.

Cohen, J. (1988). *Statistical power analysis for the behavioral sciences* (2nd ed.). Hillsdale, NJ: Erlbaum.

Dong, P., Huang, I. X., & Zhong, C.-B. (2015). Ray of hope: Hopelessness increases preference for bright lighting. *Social Psychology and Personality Science*, *6*, 84–91.

Duncan, L. A., Schaller, M., & Park, J. H. (2009). Perceived vulnerability to disease: Development and validation of a 15-item self-report instrument. *Personality and Individual Differences*, *47*, 541–546.

Fujita, K., Trope, Y., Liberman, N., & Levin-Sagi, M. (2006). Construal levels and self-control. *Journal of Personality and Social Psychology*, *90*, 351–367.

Harris, P. R., Griffin, D. W., & Murray, S. (2008). Testing the limits of optimistic bias: Event and person moderators in a multilevel framework. *Journal of Personality and Social*

Depite being "permanently" archived, the OSF and Psych Science allowed these files to be deleted.
They are now available from:
https://researchbox.org/2936

dures for probing interactions in OLS and logistic regression: SPSS and SAS implementations. *Behavior Research Methods*, *41*, 924–936.

Janz, N. K., & Becker, M. H. (1984). The health belief model: A decade later. *Health Education & Behavior*, *11*, 1–47.

Johnson, E., & Tversky, A. (1983). Affect, generalization, and the perception of risk. *Journal of Personality and Social Psychology*, *45*, 20–31.

Kalichman, S. C. (1994). Magic Johnson and public attitudes toward AIDS: A review of empirical findings. *AIDS Education and Prevention*, *6*, 542–557.

Krisch, J. A. (2016). Americans are abusing antibiotics, and it's a huge problem. *The Week*. Retrieved from http://theweek.com/articles/635520/americans-are-abusing-antibiotics-huge-problem

Liberman, N., & Trope, Y. (1998). The role of feasibility and desirability considerations in near and distant future decisions: A test of temporal construal theory. *Journal of Personality and Social Psychology*, *75*, 5–18.

Liviatan, I., Trope, Y., & Liberman, N. (2008). Interpersonal similarity as a social distance dimension: Implications for perception of others' actions. *Journal of Experimental Social Psychology*, *44*, 1256–1269.

Lockwood, P., Jordan, C. H., & Kunda, Z. (2002). Motivation by positive or negative role models: Regulatory focus determines who will best inspire us. *Journal of Personality and Social Psychology*, *83*, 854–864.

Mandrik, C. A., & Bao, Y. (2005). Exploring the concept and measurement of general risk aversion: An empirical investigation. In G. Menon & A. Rao (Eds.), *NA - Advances in consumer research* (Vol. 32, pp. 531–539). Duluth, MN: Association for Consumer Research.

Meischke, H., Sellers, D. E., Robbins, M. L., Goff, D. C., Daya, M. R., Meshack, A., . . . Hand, M. M. (2000). Factors that influence personal perceptions of the risk of an acute myocardial infarction. *Behavioral Medicine*, *26*, 4–13.

Navarrete, C. D., & Fessler, D. M. (2006). Disease avoidance and ethnocentrism: The effects of disease vulnerability and disgust sensitivity on intergroup attitudes. *Evolution and Human Behavior*, *27*, 270–282.

Neuberg, S. L., Kenrick, D. T., & Schaller, M. (2011). Human threat management systems: Self-protection and disease avoidance. *Neuroscience & Biobehavioral Reviews*, *35*, 1042–1051.

Perloff, L. S., & Fetzer, B. K. (1986). Self-other judgments and perceived vulnerability to victimization. *Journal of Personality and Social Psychology*, *50*, 502–510.

Spencer, S. J., Zanna, M. P., & Fong, G. T. (2005). Establishing a causal chain: Why experiments are often more effective than mediational analyses in examining psychological processes. *Journal of Personality and Social Psychology*, *89*, 845–851.

Steidle, A., Werth, L., & Hanke, E. (2011). You can't see much in the dark: Darkness affects construal level and psychological distance. *Social Psychology*, *42*, 174–184.

Suedfeld, M., & Schaller, P. (2002). Authoritarianism and the Holocaust: Some cognitive and affective implications. In L. S. Newman & R. Erber (Eds.), *Understanding genocide: The social psychology of the Holocaust* (pp. 68–90). Oxford, England: Oxford University Press.

Trope, Y., & Liberman, N. (2010). Construal-level theory of psychological distance. *Psychological Review*, *117*, 440–463.

Vallacher, R. R., & Wegner, D. M. (1987). What do people think they're doing? Action identification and human behavior. *Psychological Review*, *94*, 3–15.

Vallacher, R. R., & Wegner, D. M. (1989). Levels of personal agency: Individual variation in action identification. *Journal of Personality and Social Psychology*, *57*, 660–671.

Wakslak, C., & Trope, Y. (2009). The effect of construal level on subjective probability estimates. *Psychological Science*, *20*, 52–58.

Weinstein, N. D. (1980). Unrealistic optimism about future life events. *Journal of Personality and Social Psychology*, *39*, 806–820.

Xu, A. J., & Labroo, A. A. (2014). Incandescent affect: Turning on the hot emotional system with bright light. *Journal of Consumer Psychology*, *24*, 207–216.

Zhang, M., & Wang, J. (2009). Psychological distance asymmetry: The spatial dimension vs. other dimensions. *Journal of Consumer Psychology*, *19*, 497–507.

Zhong, C.-B., Bohns, V. K., & Gino, F. (2010). Good lamps are the best police: Darkness increases dishonesty and self-interested behavior. *Psychological Science*, *21*, 311–314.