Haze Blocks the Windows to the Soul: The Role of Anonymity in the Unethical Effects of Air Pollution

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Abstract

Objective: Air pollution is a global concern with both health and psychological costs. Drawing upon the unethical impacts of air pollution, this paper proposes that haze could give rise to immoral tendencies through enhanced anonymity. Methods & Results: Big data analysis of daily web searches across a period of three years revealed that an increase in web searches for immoral words was associated with hazy days. Three subsequent experiments established the causal effects of psychologically experiencing haze or personally experiencing hazy days on immoral intentions and cheating behaviors. Moreover, these effects were mediated by perceived anonymity, intensified by the low visibility in haze. In support of deindividuation, masking, which could boost perceived anonymity, amplified the unethical effects of air pollution. Conclusions: Taken together, these findings suggest that perceived anonymity was a key psychological process underlying the unethical effects of haze. The findings of the study provide insights for researchers and policy makers to tackle the adverse effects of anonymity, especially on polluted days.

Full Text

Preamble

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Abstract

Objective: Air pollution is a global concern with both health and psychological costs. Building upon research demonstrating the unethical impacts of air pollution, this paper proposes that haze may give rise to immoral tendencies through enhanced anonymity.

Methods & Results: Big data analysis of daily web searches over a three-year period revealed that increased searches for immoral words were associated with hazy days. Three subsequent experiments established the causal effects of psychologically experiencing haze or personally experiencing hazy days on immoral intentions and cheating behaviors. Moreover, these effects were mediated by perceived anonymity, intensified by the low visibility in haze. In support of deindividuation theory, masking—which could boost perceived anonymity—amplified the unethical effects of air pollution.

Conclusions: Taken together, these findings suggest that perceived anonymity is a key psychological process underlying the unethical effects of haze. The study provides insights for researchers and policymakers to tackle the adverse effects of anonymity, especially on polluted days.

Keywords: Haze; Anonymity; Unethical behavior

1. Introduction

Air pollution has become a global environmental issue over the past century, and the relationship between air pollution and behavior has received considerable attention regarding its psychological impacts (Rotton et al., 1978; Szyszkowicz et al., 2010). Alongside the social effects of air pollution (Gong et al., 2020), haze is not only highly polluting and harmful to physical health but also gives rise to immoral social behaviors (Kim et al., 2012; Li & Peng, 2016). However, evidence remains scarce on how air pollution contributes to unethical behavior.

The perceived anonymity provided by haze may explain the link between unethical behavior and air pollution. First, anonymity could be generated from low visibility during haze (Rajper, Ullah, & Li, 2018), which further adversely affects morality. Research on the dark-room effect has shown that people in dimly lit environments are more prone to antisocial behavior, and dark rooms are more likely to induce aggressive behavior and crimes (Karnes, 1960; Hartley, 1974; Hegarty & Sims, 1978; Page & Moss, 1976). Second, anonymity is enhanced when people wear masks to prevent breathing in air pollutants on hazy days; unethical acts have been proven to be more frequent when individuals are masked or disguised (Mathes & Guest, 1976; Kerr, 1999; Sassenberg & Postmes, 2002). Moreover, people wearing sunglasses may become more selfish (Zhong, Bohns, & Gino, 2010). Additionally, participants administered more shocks when made anonymous by masks and overalls reminiscent of the Ku Klux Klan (Zimbardo, 1969; Johnson & Downing, 1979). This suggests that during recent riots, anonymity may have had an overall effect on aggressive tendencies that produced antinormative behaviors.

The purpose of the present study was to investigate the impact of air pollution on morality and elucidate the possible underlying role of anonymity. Specifically, we suggest that under haze, when individuals perceive themselves to be more anonymous—produced by lowered visibility or masking—unethical behaviors may emerge.

2.1 Air pollution predicts unethical behavior

Unethical behavior is morally unacceptable and strongly prohibited by law or societal expectations (Kaptein, 2008). Studies have suggested a positive correlation between air pollution and unethical behaviors (Lu, 2019). For example, a positive correlation has been found between increased criminality (aggressive and violent behaviors) and air pollution (Anderson, 2001; Cohn & Rotton, 2005). Moreover, participants who felt "physically clean" (as opposed to those led to feel "physically dirty") tended to make more severe moral judgments on various social issues (Zhong, Strejcek, & Sivanathan, 2010). More importantly, a recent study proposing the "clear sky" effect provided further evidence of the ethical costs of air pollution, in which participants reported higher levels of perceived corruption subsequent to recalling feelings concerning haze or experiencing hazy days (Huang et al., 2016). Supporting this line of reasoning, air pollution (and haze in particular) could wreak havoc on morality (Hypothesis 1).

2.2 Air pollution, anonymity and unethical behavior

Anonymity is defined as "non-identifiability," and it raises issues of accountability (Wallace, 1999). Several approaches have been used to study increasing anonymity, such as disguising participants' physical appearance (Miller & Rowold, 1979), preventing participants from chatting with each other (Propst, 2010), or seating participants in a dimly lit room (Spivey & Prentice-Dunn, 1990). Anonymity on hazy days could reach high levels, which could be associated with certain psychological impacts.

On the one hand, air pollution and haze can induce dark smog, which decreases visibility and promotes anonymity. The main pollutants causing haze are the primary factors leading to a decline in visibility (Rajper, Ullah, & Li, 2018). Anonymity initiated by darkness and invisibility as a result of air pollution conceals people' s identity and decreases their inhibitions, after which unethical behaviors are more likely to occur. Indeed, criminality is most likely to occur during darkness (Hegarty & Sims, 1978), and dark rooms have been found to promote aggressive behavior (Page & Moss, 1976). Studies have also shown that participants in a room with slightly dimmed lighting earned more undeserved money than those in a well-lit room, and participants wearing sunglasses acted more selfishly than those wearing spectacles with clear lenses (Zhong, Bohns, & Gino, 2010). Therefore, anonymity generated from the dark smog would play a mediating role between air pollution and antisocial behavior (Hypothesis 2).

On the other hand, the ethical effects of haze are expected to be most pronounced if individuals are wearing a mask, which provides a greater sense of anonymity. Owing to severe air pollution, there is an increasing tendency for people to wear face masks on polluted days to ward off the effects of heavy haze. For instance, the haze crisis in 2013 in South Asia led to massive demand to stock up on N-95 masks (Ho et al., 2014). However, masking contributes to deindividuation, meaning that people become more likely to engage in disinhibited behavior that violates social norms (Zimbardo, 1969). Anonymity has been examined in connection with behavior that is self-interested (Kerr, 1999), antisocial (Silke, 2003), and unethical (White, 1977). Thus, we hypothesized that people wearing a face mask would be more likely to behave unethically under pollution (Hypothesis 3).

Interestingly, some researchers have proposed that polluted air influences morality due to its effect on negative emotions (e.g., anxiety) (Lu et al., 2018; Xiang et al., 2017). For example, Lu et al. (2018) found that air pollution heightened anxiety, which, in turn, increased unethical behavior. However, the mediating role of negative affect is not consistent across studies (Huang et al., 2016). Whether negative affect could explain the link between air pollution and morality requires further investigation.

2.3 Overview of our studies

The purpose of this study was to investigate the relationship between haze and immorality. More importantly, this study aimed to unravel the role of anonymity in the unethical effects of air pollution and to ascertain the mediating role of negative affect. Hypotheses were tested in four studies using big data, field observation, and experimental designs. In Study 1, air pollution and unethical behavior were examined using the Baidu Index™ as a form of big data to explore the relationship between air quality and immoral tendency. To explore whether anonymity might be one of the underlying mechanisms of the ethical costs of haze, Study 2 manipulated perceived air pollution with priming to examine whether psychologically experiencing haze and fog led to a higher incidence of immoral behaviors. Study 3 then directly examined whether the unethical effect of haze was mediated by the perceived anonymity produced by the low visibility of polluted days in real-life situations. Finally, Study 4 ascertained whether wearing a face mask, which intensified perceived anonymity, would boost the ethical effects of haze. Therefore, the study set out to provide a more in-depth understanding of perceived anonymity as a key psychological process underlying the unethical effects of haze.

3.1 Study 1: Analyses of big data

Study 1 explored the association between air pollution and unethical behavior using big data in the form of Internet searches. In general, Internet searches should be a suitable tool to access conscious cognitive awareness and behavioral tendencies (Broder, 2002). Research studies have used Google Trends™ to predict a range of outcomes: economic prospects, disease outbreaks, and political movements (e.g., Carneiro & Mylonakis, 2009). In China, the most frequently used search engine is Baidu. The Baidu Index offers the same function as Google Trends, indicating when search terms were inputted. Hence, we focused on the Baidu Index as a form of big data to investigate different ethical tendencies under different air quality conditions. We expected that on hazy days, the search volume for immoral words would be larger than on clear days, while there would be little difference for moral words.

3.1.1 Data collection

Air quality. We sourced daily data on Beijing air pollution between 2017 and 2019 from the National Air Quality Monitor Net (www.cnpm25.cn/city/beijing.html). The Air Quality Index (AQI) is based on the level of six atmospheric pollutants and is used to measure the level of air pollution in China (Ministry of Environmental Protection of the People' s Republic of China, 2018). According to pollution standards, when the AQI is < 50 the weather is classified as "clear" ; when AQI is > 100, the weather is classified as "hazy." Between 2017 and 2019 in Beijing, there were 247 clear days and 316 hazy days in total.

Moral tendency. Ten words were adapted from the Moral Awareness word list (Barnes, Gunia, & Wagner, 2015), which was generated based on content and word frequency. Five words served as representing web searches with an immoral tendency ("Corrupt," "Fraud," "Sin," "Steal," "Cheat") and five to represent those with a moral tendency ("Ethics,""Fair,""Honest,""Truth,""Principle"). To validate that the terms classified as Moral Words were higher in moral content than those classified as Immoral Words, a pilot study with 30 participants was conducted. Participants rated the degree to which each word related to immorality on a seven-point scale. The daily search volume in the Baidu Index for each term from 2017 to 2019 in Beijing was web scraped using code written in Python 3.5 (detailed codes are shown in the Appendix). The Baidu Index provided normalization against search volume for regions and dates specified in search queries.

3.1.2 Results

Validation of the terms classified as Moral Words and Immoral Words showed that the ratings of immorality for terms classified as Immoral Words (M = 6.13, SD = 0.51) were significantly higher than those for terms classified as Moral Words (M = 2.01, SD = 0.35), $t(29) = 34.74$, $p < .001$, Cohen' s $d = 9.42$. Thus, it was appropriate to contrast web search activity for Moral Words and

Immoral Words.

A two-way repeated measures ANOVA examined differences in the Baidu Index for different search categories and air quality. A significant main effect of word category was found ($F(1, 561) = 4049.74$, $p < .001$, $^2 = 0.88$), indicating a higher volume of web searches for Moral Words ($M = 154.56$, $SD = 23.17$) compared with those for Immoral Words ($M = 100.36$, $SD = 25.36$). There was no main effect of air quality ($F(1, 561) = 1.35$, $p = .246$, $^2 = 0.002$). However, more strikingly, an interaction effect of word category and daily air quality was revealed ($F(1, 561) = 18.05$, $p < .001$, $^2 = 0.03$). Further tests revealed that for Moral Words, no significant differences were found between web searches on clear days ($M = 155.39$, $SD = 25.49$) and hazy days ($M = 153.91$, $SD = 21.18$), $F(1, 561) = 0.56$, $p = .453$; however, for Immoral Words, an increase in web searches was associated with hazy days ($M = 102.91$, $SD = 25.09$) compared to clear days ($M = 97.09$, $SD = 25.39$), $F(1, 561) = 7.38$, $p = .007$, $^2 = 0.13$. This indicated that low air quality was related to a higher volume of web searches for immoral words [Figure 1: see original paper].

3.1.3 Discussion

By analyzing big data from the Baidu Index, Study 1 provided evidence that on hazy days, people tended to search more for immoral words, indicating a higher tendency for unethical behaviors. However, air quality was not correlated with differences in web searches for moral words, indicating that the increase in immoral tendency on hazy days was not caused by a general increase in moral awareness. The results supported the view that air pollution could increase unethical tendency. Although the findings from Study 1 provided some hints regarding the ethical effects of air pollution, they lacked evidence indicating that anonymity played an important role in the unethical costs of haze. Therefore, Study 2 aimed to ascertain whether the anonymity provided by the invisibility of hazy days could explain this link.

3.2 Study 2: Effect of air pollution on morality

Study 2 first examined whether psychologically experiencing haze would result in unethical consequences. Second, to examine whether anonymity plays an important role in the ethical effects of haze, hazy days were distinguished from foggy days. During foggy days, although the air is not polluted, it leads to poor visibility and perceived brightness, just as on hazy days. Therefore, hazy days and foggy days bring about a higher level of anonymity than clear days. If anonymity is one of the underlying mechanisms of the ethical costs of haze, then unethical behaviors would be as likely to appear on hazy days as on foggy days. Moreover, the role of negative affect on the unethical effects of pollution was examined to test whether anxiety is a mediating mechanism in reduced morality.

3.2.1 Methods

Participants. G*Power was used to determine the sample size to achieve a medium-to-large effect size and a power of 85%. A total of 126 undergraduate and graduate students (42 males, M_{age} = 19.96, SD_{age} = 1.61) were recruited for this experiment and received either course credits or monetary rewards for their participation. The experiment was ethically approved by the Institutional Review Board for Human Participants.

Design. A between-participants design was used, with participants randomly assigned to three conditions: polluted, clear, and foggy.

Materials

Experimental manipulation. A series of photographs of contemporary cities displayed on a computer monitor were shown to participants. There were 20 photographs in each group, featuring a polluted version, a clear version, and a foggy version of the same geographical location. One photograph was taken on a polluted day (i.e., smoggy sky, low visibility), one was taken on a clear day (i.e., clean sky, high visibility), and another was taken on a foggy day (i.e., clean sky, low visibility) [Figure 2: see original paper]. While viewing the photographs, individuals were required to imagine that they were living in that city. Then, participants were asked to complete a detailed diary in 3–5 minutes about living in the city, with the following instruction: "Go through the city on a day like this as if you were there as a local, looking around, taking a bus, exploring the city, going to classes, riding a bike, breathing the air, talking with your friends" (Lu et al., 2018, p. 350).

Manipulation check. Participants were asked to assess perceived air quality and visibility on a seven-point Likert scale (1: "extremely bad," 7: "extremely good"). Perceived light quality was rated using the dimensions "drab-clear,""subdued-brilliant," "dark-light," "shaded-glaring," "mild-sharp," and "unfocused-focused," from 1 to 7 (Johansson et al., 2014). Cronbach' s α was 0.98.

Emotions. Emotions were measured by the Positive and Negative Affect Schedule, Chinese version (PANAS-X: Watson, Clark, & Tellegen, 1988; PANAS-X-Chinese version: Guo & Gan, 2010). It consisted of 18 words and phrases describing positive and negative feelings. Individuals rated each word or phrase on a five-point Likert scale (1: "very slightly or not at all" and 5: "extremely") according to their feelings at that time. Cronbach' s α for positive and negative affect were 0.97 and 0.95, respectively.

Unethical decision-making. A scenario-based measure of unethical decision-making was used to assess participants' moral judgments (Detert, Treviño, & Sweitzer, 2008). Eight "ethically charged" scenarios were introduced, and participants were instructed to imagine themselves as the target person in each ethical situation. A sample scenario was: "You work in a fast-food restaurant in downtown [City X]. It' s against policy to eat food without paying for it. You came straight from classes and are therefore hungry. Your supervisor isn' t around, so you make something for yourself and eat it without paying." Participants were asked to evaluate three questions concerning likelihood judgment, acceptability, and moral attitude on a seven-point Likert scale. Cronbach' s α for the scales were 0.69, 0.73, and 0.72, respectively.

Cheating behavior. A problem-solving matrix task was also used to measure unethical behavior (adapted from Kouchaki & Wareham, 2015). Participants were instructed that they would earn an additional 0.5 yuan for each correctly solved matrix (i.e., "Find the two numbers in the matrix that add up to 10") and were presented with 20 matrices of 12 three-digit numbers (e.g., 3.86) appearing on the screen for 15 seconds each [Figure 3: see original paper]. Participants were asked to only indicate whether or not they found the matching pair for each matrix. Half of the matrices (n = 10) were solvable (i.e., containing two numbers adding up to 10), whereas the other half were unsolvable (i.e., not containing two numbers adding up to 10). Thus, if a participant reported having solved a pair in a matrix that could not be resolved, it clearly indicated that he/she was cheating on that matrix. This task allowed for measuring cheating behavior, as represented by the number of reported resolved matrices that were unsolvable.

3.2.2 Results

As expected, participants' assessments of air quality varied by condition ($F(2, 123) = 216.18$, $p < .001$, $^2 = 0.78$). In particular, participants rated significantly lower levels of air quality in the haze condition ($M = 1.45$, $SD = 0.89$) compared with the fog condition ($M = 2.02$, $SD = 0.84$, $t(82) = 3.03$, $p = .003$, Cohen' s $d = 0.66$) and clear condition ($M = 5.79$, $SD = 1.32$, $t(82) = 17.68$, $p < .001$, Cohen's $d = 3.86$), respectively. Also, foggy days were evaluated as having worse air quality than clear days ($t(82) = 15.61$, $p < .001$, Cohen' s $d = 3.41$). With regard to visibility, participants primed with haze ($M = 1.90$, $SD = 1.03$, $t(82) = 16.18$, $p < .001$, Cohen' s $d = 3.54$) and fog ($M = 2.31$, $SD = 0.72$, $t(82) = 16.43$, $p < .001$, Cohen' s $d = 3.5$) photographs reported lower levels of visibility than those in the clear condition ($M = 5.88$, $SD = 1.21$), $F(2, 123) = 197.89$, $p < .001$, $^2 = 0.76$; but no significant differences were found between haze and fog conditions ($t(82) = 2.09$, $p = .205$). The same pattern of results appeared for light quality. These data suggested that the priming pictures were successful in guiding participants to experience three types of weather. Specifically, although foggy days and hazy days were rated as having low visibility and light quality, the haze condition was considered more polluted than the fog condition.

Examination of the emotional effects of different conditions revealed significant between-participant results for positive affect ($F(2, 123) = 127.57$, $p < .001$, $^2 = 0.68$) and negative affect ($F(2, 123) = 70.58$, $p < .001$, $^2 = 0.53$). Participants primed with haze experienced higher levels of negative emotions ($M = 2.98$, $SD = 0.92$) and lower levels of positive emotions ($M = 1.42$, $SD = 0.50$) than participants in foggy conditions (respectively, $M = 2.46$, $SD = 0.82$, $t(82) = 2.74$, $p = .023$, Cohen' s $d = 0.60$; $M = 1.86$, $SD = 0.62$, $t(82) = 3.65$, $p = .001$, Cohen' s $d = 0.78$) and clear conditions (respectively, $M = 1.16$, $SD = 0.26$, t(82) = 12.39, p < .001, Cohen' s d = 2.69; M = 3.57, SD = 0.80, t(82) = 14.74, p < .001, Cohen' s d = 3.22). Moreover, fog priming elicited greater negative affect and lower positive affect than clear priming (respectively, t(82) = 9.89, p < .001, Cohen' s d = 2.13; t(82) = 10.92, p < .001, Cohen' s d = 2.39).

As predicted, acceptance of immoral behaviors in scenario tests differed across conditions (F(2, 123) = 6.74, p = .002, ^{2} = 0.10). Participants in haze (M = 3.60, SD = 0.97) and fog (M = 3.84, SD = 0.95) conditions, compared with the clear condition (M = 3.11, SD = 0.83), showed greater acceptance of immoral behaviors (respectively, t(82) = 2.46, p = .016, Cohen' s d = 0.54; t(82) = 3.71, p < .001, Cohen' s d = 0.81). Also, participants primed with a clear sky had higher levels of moral regulation, F(2, 123) = 5.21, p = .007, ^{2} = 0.08. Individuals in the clear condition (M = 2.43, SD = 0.80) had lower scores on the should/should not subscale than those in fog (M = 2.93, SD = 0.71, t(82) = 3.03, p = .033, Cohen' s d = 0.66) and haze conditions (M = 2.93, SD = 0.93, t(82) = 2.63, p = .010, Cohen' s d = 0.58). Moreover, there were no significant differences between the haze condition and fog condition for moral acceptance or moral attitude (respectively, t(82) = 1.13, p = .889; t(82) < 0.001, p > .05).

Interestingly, differences were not found on the likelihood subscale. This might have been due to the "social desirability" of this measure, which contributed to recognition of other factors that led to these decisions. Thus, the likelihood scale may be a less direct measure of moral judgments.

Regarding the problem-solving matrix task, priming conditions had a significant effect on the number of cheating episodes (F(2, 123) = 5.47, p = .005, ^{2} = 0.08). Participants in the haze (M = 3.50, SD = 3.34, t(82) = 3.49, p = .001, Cohen' s d = 0.76) and fog conditions (M = 3.12, SD = 3.49, t(82) = 2.73, p = .008, Cohen' s d = 0.59) reported solving more unsolvable matrices than those in the clear condition (M = 1.50, SD = 1.63). Haze priming and fog priming did not lead to differences in cheating (t(82) = 0.51, p = .940). This indicated that participants in all conditions cheated to some extent, but haze priming and fog priming gave rise to more cheating.

However, neither priming conditions (clear = 0, foggy = 1, hazy = 2) (b = 0.54, SE = 0.45, p = .236) nor negative affect (b = 0.50, SE = 0.35, p = .157) were significantly correlated with occurrences of cheating in the multivariate model. As a result, negative emotions were not a significant mediator between weather and cheating (95% CI [-0.30, 1.19]).

3.2.3 Discussion

Study 2 used experiments to establish the causal relationship between hazy weather and unethical behaviors, revealing that on hazy days people were more likely to engage in cheating. The findings also indicated that experiencing haze discouraged moral acceptability and attitudes, with greater acceptance of immoral behaviors and lower levels of moral regulation. These data are in accordance with Hypothesis 1.

More importantly, haze and fog led people to behave unethically to the same degree. Although foggy days have low visibility, they have better air quality than hazy days. Thus, it might not be the pollution itself on hazy days that led to more cheating, but the anonymity provided by low visibility on hazy days. This preliminary result refuted the notion that air pollutants license more unethical behaviors. Instead, the dim and vague sky during hazy days might be the cause.

In addition, although negative emotions were increased by air pollution, results showed that the unethical effects of haze were not mediated by negative emotion. This is not consistent with previous studies. Lu et al. (2018) compared the anxiety levels of participants primed by hazy days and clear days and found that air pollution heightened anxiety, which in turn increased unethical behavior. This might be due to different measurements of negative emotions. In our study, the mediation effect of negative emotions tested with PANAS scales was found to be insignificant (Huang et al., 2016), whereas with the anxiety scale Lu et al. (2018) found polluted morality to be mediated by anxiety.

3.3 Study 3: Mediating role of anonymity

Although Study 2 suggested that air pollution could license unethical behavior, there was a lack of direct evidence showing that anonymity is an important mediator in the ethical costs of haze. In addition, laboratory experimental designs lack the external validity to verify whether an ethical effect also occurs in real-life situations. Hence, Study 3 sought to ascertain whether the moral costs of air pollution through anonymity could be applied to real life.

3.3.1 Methods

Participants. G*Power was used to determine the sample size to achieve a medium-to-large effect size and a power of 85%; 38 participants were needed in each condition (hazy and clear days). Four extra participants per condition were recruited, resulting in 84 individuals (21 males, $M_{age} = 21.49$, $SD_{age} = 2.41$) in total. Participants were recruited via face-to-face encounters outside a student shop at a university in Beijing. The Institutional Review Board for Human Participants approved the execution of the research.

Design. A between-participants design was used. Participants were approached either on hazy days or clear days; all participants were selected randomly.

Materials

Air pollution. The study was conducted across four days in April 2019. We categorized the weather as "hazy" (AQI > 100) or "clear" (AQI < 50) according to data published on the National Air Quality Monitor Net . Also, participants were asked to rate perceived air quality and perceived visibility for a manipulation check.

Anonymity. The five-item anonymity measure (Zhong, Bohns, & Gino, 2010) was adapted to assess the extent to which individuals perceived themselves to be anonymous under the weather conditions that day (e.g., "With the weather conditions today, I am likely to be watched"). Participants indicated their agreement on a seven-point Likert scale (1 = "strongly disagree," 7 = "strongly agree"). Cronbach' s α for the scale was 0.52.[1]

[1] Previous studies have revealed that Cronbach' s α could be accepted at around 0.6 when conducting psychological research (Devellis, 1991), thus it is still reasonable to use the scale.

Cheating behavior. The problem-solving matrix task used in Study 2 was conducted to measure unethical behavior (adapted from Kouchaki & Wareham, 2015). The 20 matrices were the same as those in Study 2, except that the matrices were printed on hard copy for participants to complete on the questionnaire. Cheating behavior was represented by the number of ticked resolved matrices that were unsolvable.

3.3.2 Results

Descriptive statistics and correlations are shown in Table 2 . As a manipulation check, participants reported significantly lower air quality on hazy days relative to those reported on clear days ($t(82) = 6.35$, $p < .001$, Cohen' s $d = 1.39$). Participants' ratings of visibility of the day were significantly lower when it was hazy than when it was clear ($t(82) = 4.17$, $p < .001$, Cohen' s $d = 0.91$). Thus, participants' responses corresponded with actual haze data.

As expected, participants experiencing hazy weather reported a significantly higher level of perceived anonymity compared with those who experienced clear weather ($t(82) = 2.64$, $p = .010$, Cohen' s $d = 0.58$). More importantly, participants on hazy days reported solving a higher number of unsolvable matrices than those on clear days ($t(82) = 2.52$, $p = .014$, Cohen' s $d = 0.55$). These results showed that participants who completed the task on hazy days cheated more.

Mediation analysis indicated that haze had a significant effect on perceived anonymity ($b = 0.45$, $SE = 0.17$, $p = .010$), which in turn significantly affected the reported number of unsolvable matrices ($b = 1.08$, $SE = 0.38$, $p = .006$). The effect of haze was reduced (from $b = 1.55$, $SE = 0.61$, $p = .014$ to $b = 1.06$, $SE = 0.61$, $p = .088$) when perceived anonymity was included in the equation. This indicated that perceived anonymity mediated the effect of air pollution on cheating behavior, 95% CI = [0.073, 1.039] [Figure 4: see original paper].

3.3.3 Discussion

Study 3 replicated the findings of Study 2 in real-life situations when individuals physically experienced haze. The results provided support for the mediating role of anonymity provided by low visibility as predicted by Hypothesis 2. On hazy days, people perceive themselves to be more anonymous, which in turn increases their tendency to behave unethically.

3.4 Study 4: Perceived anonymity of masking

In hazy weather, people' s perceived anonymity is increased not only because of the low visibility of the day but also due to masking, which derives from the intention of preventing exposure to air pollutants. In Study 4, we preliminarily examined whether wearing a mask would result in more unethical behaviors. Moreover, we examined the role of anxiety again to verify the previous finding of whether negative emotions, especially anxiety, might play a mediating role in the relationship between air pollution and immorality.

3.4.1 Methods

Participants. G*Power was used to determine the sample size to achieve a medium-to-large effect size and a power of 88%, requiring 30 participants for each condition. Therefore, a total of 120 undergraduate and graduate students (25 males, M_{age} = 21.07, SD_{age} = 2.30) were recruited for this experiment. They received course credits and monetary rewards for their participation. The research was carried out under the approval of the Institutional Review Board for Human Participants.

Design. We used a 2 (air priming: fog, haze) × 2 (masking: yes, no) between-participants design. Participants were randomly assigned to one of the four conditions.

Materials

Anonymity manipulation. In the masked condition, participants were asked to wear a gauze mask before entering the laboratory [Figure 5: see original paper]. Participants in the control condition took part in the study without a mask.

Haze priming. Participants were exposed to the polluted version or foggy version of the photographs (the same procedure as in Study 2). Cronbach' s α for the light-quality scale was 0.83.

Manipulation check. The anonymity of masking was confirmed with a five-item measure of perceived anonymity (e.g., "My choice went unnoticed during the study") (Zhong, Bohns, & Gino, 2010). Participants indicated their agreement on a seven-point Likert scale (1 = "strongly disagree," 7 = "strongly agree"). Cronbach' s α was 0.74.

Anxiety. Six items ("anxious," "calm," "neutral," "relaxed," "tense," and "upset") adapted from the short Spielberger State–Trait Anxiety Inventory (Marteau & Bekker, 1992) were used to measure the extent to which participants felt these emotions at that time (1 = "not at all," 4 = "very much"). Cronbach' s α was 0.69.

Unethical behavior. Participants undertook a dot estimation task [Figure 6: see original paper] to ostensibly assess their memory ability but in reality measured cheating (Lambirth, Gibb, & Alcorn, 1986). Participants were presented with a series of pictures with a white background and 80 blue dots. The task instructed them to judge whether the left or right side had more dots: pressing "A" for left and "L" for right. In fact, the dots were scattered randomly, with the same number on the left and right sides. After 50 ms of fixation, the picture lasted for only 100 ms, making them hard to detect. After each trial, participants received feedback judging their estimation as "right" or "wrong." The more "right" trials, the more monetary rewards they would receive. However, participants were told that a bug in the program had not yet been fixed and that there would be no log records about the bug. If they pressed the key "H," then they would be judged to have made a correct estimation and receive the feedback "right." Thus, the experimenter asked them not to press "H." There were 40 trials in total, and the number of trials in which participants cheated by pressing "H" was actually recorded.

Procedure. Before entering the room, participants assigned to the masking condition were asked to wear a gauze mask throughout the study. Participants in the masked group were told that this was an experiment to examine the functions of a new brand of mask, which served as a cover story to disguise the purpose of the study. Participants were first asked to complete the priming task and a 5-minute diary about how they would feel living in the city. Then, they were asked to evaluate light quality and complete the anxiety measurement. Next, they were presented with the dot estimation task to test their cheating behavior, followed by a manipulation check of anonymity. Finally, demographic information was collected, and participants in the masking group were asked to answer two questions about the comfort and protection of the mask. None of the participants in the masked or unmasked group figured out the actual purpose of the study.

3.4.2 Results

As expected, participants' assessments concerning the air varied according to condition. When examining perceived air quality, a significant main effect of priming condition was found ($F(1, 116) = 9.53$, $p = .003$, $^2 = 0.08$). Participants primed by haze photographs rated significantly lower levels of air quality in the haze condition ($M = 1.38$, $SD = 0.59$) compared with those in the fog condition ($M = 1.80$, $SD = 0.86$). No main effect of masking ($F(1, 116) = 0.75$, $p = .39$, $^2 = 0.01$) or interaction effect ($F(1, 116) = 0.02$, $p = .90$, $^2 = 0.00$) was found. Also, no significant effects or interactions were found on ratings of visibility ($ps > .05$) or light quality ($ps > .05$). These data suggested that the priming pictures were successful in guiding participants to experience hazy days and foggy days, because hazy days are more polluted than foggy days but visibility and light quality are both low on these two types of days.

Furthermore, the main effect of priming condition on reported anxiety levels was significant ($F(1, 116) = 13.54$, $p < .001$, $^2 = 0.10$, 95% CI [0.02, 0.22]). Participants in the haze condition ($M = 3.22$, $SD = 0.53$) reported significantly higher anxiety than those in the fog condition ($M = 2.81$, $SD = 0.68$). Masking and the interaction did not show significant effects on anxiety ($F(1, 116) = 0.65$, $p = .421$, $^2 = 0.01$; $F(1, 116) = 0.57$, $p = .45$, $^2 = 0.01$). This indicated that the air pollution resulting from haze contributed to a higher level of anxiety.

With respect to anonymity, a significant main effect of masking was revealed ($F(1, 116) = 12.85$, $p < .001$, $^2 = 0.10$). As predicted, participants wearing a mask ($M = 4.93$, $SD = 1.04$) reported a higher level of perceived anonymity than those without a mask ($M = 4.76$, $SD = 1.36$). There were no significant differences between priming conditions or interactions ($F(1, 116) = 0.61$, $p = .437$, $^2 = 0.01$; $F(1, 116) = 3.24$, $p = .07$, $^2 = 0.03$). This demonstrated that the manipulation of masking was successful in enhancing participants' anonymity.

Results showed significant differences between air priming conditions and the occurrence of cheating ($F(1, 116) = 5.24$, $p = .024$, $^2 = 0.04$). Participants in the haze condition ($M = 17.52$, $SD = 16.48$) pressed the cheating key ("H") more often than those in the fog condition ($M = 11.72$, $SD = 14.47$). A main effect of masking was also found ($F(1, 116) = 25.64$, $p < .001$, $^2 = 0.18$), indicating that individuals wearing a mask ($M = 21.03$, $SD = 15.63$) cheated more often than those not wearing a mask ($M = 8.20$, $SD = 13.04$). In addition, the interaction between priming conditions and masking was significant ($F(1, 116) = 5.61$, $p = .020$, $^2 = 0.05$). Simple effects analysis suggested that when participants were not wearing a mask, there were no significant differences in cheating between the hazy priming condition and foggy priming condition ($F(1, 116) < 0.01$, $p > .05$). However, with a mask, participants primed by haze ($M = 26.93$, $SD = 14.83$) pressed the cheating "H" key more times than those primed by fog ($M = 15.13$, $SD = 14.32$, $F(1, 116) = 10.84$, $p = .001$, $^2 = 0.09$). These data demonstrated that wearing a mask and experiencing hazy weather would lead to a greater tendency toward unethical behavior, and individuals wearing a mask on hazy days would be more likely to become involved in cheating [Figure 7: see original paper].

However, neither haze ($b = 4.54$, $SE = 2.98$, $p = .131$) nor anxiety ($b = 3.12$, $SE = 2.37$, $p = .190$) were significantly correlated with cheating in the multivariate model. As a result, anxiety was not a significant mediator between haze and unethical behavior (95% CI [-0.48, 3.43]).

3.4.3 Discussion

Participants experiencing hazy weather tended to cheat more frequently relative to those experiencing foggy weather, but this effect was limited to participants who were more anonymous by wearing a mask. Thus, wearing a face mask during hazy days enhances immorality, which could be influenced by haze. Also, the results supported previous findings, which did not show a significant mediating role of anxiety, even with the same measurement as Lu et al. (2018).

4. Discussion

Using big data and three experiments, we found that experiencing haze led to unethical behaviors and that anonymity might be the underlying mechanism. The low visibility of haze boosts perceived anonymity, thus resulting in immoral behaviors and judgments. Also, wearing a face mask during hazy days enhances the immorality that haze produces, thereby indicating the moderating role of masking. Additional results also suggested that, although anxiety was increased by haze, it was not the underlying mechanism linking haze and unethical behaviors.

4.1 Polluted morality

Our findings suggest that the physical environment and contextual cues could affect the tendency to behave unethically. In accordance with "broken-windows theory," it has been found that a disordered physical environment could induce immorality. Indeed, people are more likely to litter, jaywalk, and steal when stimulated by disorder in the physical environment (Keuschnigg & Wolbring, 2015). These results corroborate previous research indicating that on clear days individuals were more likely to return wallets (Zhao, Gao, & Zhou, 2020). Also, embodied cognition posits that the physical environment could activate physical perceptions and related abstract concepts (Huang et al., 2016), which could also explain the relationship between weather and immorality. Our research is in line with previous studies asserting polluted morality, which have found that air pollutants could cause more criminal activity (Haynes et al., 2011) and more counterproductive work behaviors in organizational settings (Feh et al., 2017).

More strikingly, the present research proposed anonymity as the underlying mechanism of the ethical costs of haze. In fact, crimes are most likely to happen during low visibility (Hartley, 1974), and darkness promotes aggressive behavior (Karnes, 1960). According to Zhong et al. (2010), the lowered visibility produced by darkness gives rise to a sense of illusory anonymity that triggers unethical behavior. Thus, hazy days might not induce actual anonymity in social interactions, but they produce a higher level of illusory anonymity instead, triggering the belief that one is protected from the attention and scrutiny of other people. In addition, when guards failed to identify with their roles due to disguise and masking, they were found to be more reluctant to impose authority, which also supports the results of the enhanced ethical effects of haze provided by anonymity (Reicher & Haslam, 2006). Resulting from either masking or low visibility, the perceived anonymity increased cheating and unethical behaviors.

4.2 Implications and contributions

The present study has extended understanding of polluted morality in two ways. Theoretically, our findings suggest that the experience of low visibility, combined with the close link between physical and psychological feelings, triggers a fundamental belief that participants are less likely to be seen or identified. Thus, extending previous results, the impact of haze was examined in a real-life situation in which participants experienced low visibility and perceived anonymity with a face mask. Our findings have provided new insights into the underlying factors of polluted morality.

In a practical sense, our findings provide supportive evidence for policymakers. The present research indicated that haze might be the unethical "nudge" that has an extensive influence on the daily life of individuals. A cleaner sky with high air quality could attenuate the potential ethical costs of air pollution. Our results suggest that anonymity, caused either by the low visibility of haze or by masking, may have harmful consequences and induce more unethical behaviors. Moreover, air pollution would give rise to a decline in subjective happiness (Zheng et al., 2019). Accordingly, measures could be taken by governments to tackle the adverse effects of anonymity. First, a simple solution would be to invent and manufacture new types of facemasks that are transparent or smaller. A transparent mask could prevent people from inhaling air pollutants on hazy days and also discourage potential aggressive tendencies. A second measure would be for governments to prohibit wearing masks during assemblies and parades, especially on hazy days, which would help maintain harmony in cities. Moral contagion occurs in parades, when the negative emotions of rebels bring about antisocial and aggressive behaviors (Grappi, Romani, & Bagozzi, 2013). For example, during the riots in Hong Kong in 2019, demonstrators and thugs wore masks, and attacks seemed to be very determined. In these circumstances, wearing a mask would augment further the immorality of these rebels to the extent that the infrastructure of the city may be destroyed. If the revolt happened to be on a polluted day, then it would be tougher to address the violent problems that anonymity may cause to the city.

4.3 Limitations and directions for future research

Our findings indicated that the anonymity brought about by masking contributed to a higher incidence of immoral behaviors. However, the effect of anonymity might also depend on different levels and times of air pollution. Although we have categorized weather as polluted and clean, the extent to which the day is polluted is not well demarcated. A higher level of darkness and polluted air might cause more unethical behaviors (Zhong et al., 2010), and different levels of pollution could moderate the impacts of anxiety and anonymity, leading to different results and conclusions.

In addition, considering the null mediating effect of anxiety and negative emotions in the study, adaptation to air pollution might play a key role. Participants in our study were living in Beijing, which has always been a highly polluted city. According to sensory adaptation theory, when lasting environmental adaptation occurs, it is difficult to modify our emotions unless a seismic change takes place (Smith & Lazarus, 1990). Thus, it might be the case that participants have become accustomed to living under hazy days so that common polluted days would not cause emotional changes and reactions.

Moreover, environmental pollution is a multi-faceted phenomenon: besides environmental dirtiness (air pollution), there are other aspects and subtypes of physical problems in the environment that are worth exploring. For example, how do littering, graffiti, polluted water, and other forms of environmental problems affect morality? Thus, it is important for future research to explore the effects of pollution and its psychological mechanisms.

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Supporting Information

Python codes for web scraping Baidu Index of Moral and Immoral words in Study 1

Demo.py

```
from baidu_{index}.utils import test_{cookies}
from baidu_{index} import config
from baidu_{index} import BaiduIndex, ExtendedBaiduIndex

cookies = ""

if __{name}_ == "__{main}_":
    print(test_{cookies}(cookies))
    keywords = ['作弊', '贿赂', '欺骗', '盗窃', '犯罪', '真相','诚实','原则','公平','道德']
    print(config.PROVINCE_{CODE})
    print(config.CITY_{CODE})
    baidu_{index} = BaiduIndex(
        keywords=keywords,
        start_{date}='2017-01-01',
        end_{date}='2018-1-31',
        cookies=cookies,
        area=911,
    )
    for index in baidu_{index}.get_{index}():
        print(index)
```

BaiduIndex.py

```
from urllib.parse import urlencode
import queue
import datetime
import json
import requests
from . import utils

class BaiduIndex:
    _{all}_{kind} = ['all', 'pc', 'wise']

    def __{init}_(
        self,
        keywords: list,
        start_{date}: str,
        end_{date}: str,
        cookies: str,
        kind="news",
        area=0
```

```
):
    self.keywords = keywords
    self.area = area
    self.start_{date} = start_{date}
    self.end_{date} = end_{date}
    self.cookies = cookies
    self._{params}_{queue} = utils.get_{params}_{queue}(start_{date}, end_{date}, keywor

def get_{index}(self):
    while 1:
        params_{data} = self._{params}_{queue}.get(timeout=1)
        encrypt_{datas}, uniqid = self._{get}_{encrypt}_{datas}(
            start_{date}=params_{data}['start_{date}'],
            end_{date}=params_{data}['end_{date}'],
            keywords=params_{data}['keywords']
        )
        key = utils.get_{key}(uniqid, self.cookies)
        for encrypt_{data} in encrypt_{datas}:
            for kind in self._{all}_{kind}:
                encrypt_{data}[kind]['data'] = utils.decrypt_{func}(
                    key, encrypt_{data}[kind]['data']
                )
            for formated_{data} in self._{format}_{data}(encrypt_{data}):
                yield formated_{data}
        except requests.Timeout:
            self._{params}_{queue}.put(params_{data})
        except queue.Empty:
            break
        utils.sleep_{func}()

def _{get}_{encrypt}_{datas}(self, start_{date}, end_{date}, keywords):
    """
    :start_{date}; str, 2018-10-01
    :end_{date}; str, 2018-10-01
    :keyword; list, ['1', '2', '3']
    """
    request_{args} = {
        'word': json.dumps([[{'name': keyword, 'wordType': 1}] for keyword in keywords]
        'startDate': start_{date}.strftime('%Y-%m-%d'),
        'endDate': end_{date}.strftime('%Y-%m-%d'),
        'area': self.area,
    }
    url = 'http://index.baidu.com/api/SearchApi/index?' + urlencode(request_{args})
    html = utils.http_{get}(url, self.cookies)
    datas = json.loads(html)
    uniqid = datas['data']['uniqid']
```

```
        encrypt_{datas} = []
        for single_{data} in datas['data']['userIndexes']:
            encrypt_{datas}.append(single_{data})
        return (encrypt_{datas}, uniqid)

    def _{format}_{data}(self, data):
        keyword = str(data['word'])
        start_{date} = datetime.datetime.strptime(data['all']['startDate'], '%Y-%m-%d')
        end_{date} = datetime.datetime.strptime(data['all']['endDate'], '%Y-%m-%d')
        date_{list} = []
        while start_{date} <= end_{date}:
            date_{list}.append(start_{date})
            start_{date} += datetime.timedelta(days=1)
        for kind in self._{all}_{kind}:
            index_{datas} = data[kind]['data']
            for i, cur_{date} in enumerate(date_{list}):
                try:
                    index_{data} = index_{datas}[i]
                except IndexError:
                    index_{data} = ''
                formated_{data} = {
                    'keyword': json.loads(keyword.replace('\'', '"'))[0]['name'],
                    'type': kind,
                    'date': cur_{date}.strftime('%Y-%m-%d'),
                    'index': index_{data} if index_{data} else '0'
                }
                yield formated_{data}
```

Figure Legends

Fig. 1 Interaction between word category and air quality on Baidu Index for Moral Words and Immoral Words. (Study 1)

Fig. 2 Sample photographs of cities with different air quality. The left picture shows a "haze" condition, the middle picture shows a "clear" condition, and the right picture shows a "fog" condition. (Study 2)

Fig. 3 Example of unsolvable matrix. (Study 2)

Fig. 4 Testing the mediating role of anonymity provided by low visibility. Note. $^*p < .05$. $^{**}p < .01$.

Fig. 5 A sample of gauze mask.

Fig. 6 Dot estimation task.

Fig. 7 Effect of the interaction between haze and masking upon cheating.

Figures

[Figure 1: see original paper] Figure 1. Interaction between word category and air quality on Baidu Index for Moral Words and Immoral Words. (Study 1)

[Figure 2: see original paper] Figure 2. Sample photographs of cities with different air quality. The left picture shows a "haze" condition, the middle picture shows a "clear" condition, and the right picture shows a "fog" condition. (Study 2)

[Figure 3: see original paper] Figure 3. Example of unsolvable matrix. (Study 2)

[Figure 4: see original paper] Figure 4. Testing the mediating role of anonymity provided by low visibility. Note. *p < .05. **p < .01.

[Figure 5: see original paper] Figure 5. A sample of gauze mask.

[Figure 6: see original paper] Figure 6. Dot estimation task.

[Figure 7: see original paper] Figure 7. Effect of the interaction between haze and masking upon cheating.

Tables

Table 1 Daily average AQI (Study 3)

Date	Condition
25 Apr.	Clear
26 Apr.	Clear

Table 2 Descriptive statistics and correlations (Study 3)

Variable	1	2	3	4
1. Air quality	-			
2. Visibility	0.69***	-		
3. Anonymity	-0.19	-0.24*	-	
4. Cheating	-0.28*	-0.03	0.35**	-

Note. *p < .05.* ***p < .01.*** p < .001.

Note: Figure translations are in progress. See original paper for figures.

Source: ChinaXiv —Machine translation. Verify with original.