Secure human attachment can promote support for climate change mitigation

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Attachment theory is an ethological approach to the development of durable, affective ties between humans. We propose that secure attachment is crucial for understanding climate change mitigation, because the latter is inherently a communal phenomenon resulting from joint action and requiring collective behavioral change. Here, we show that priming attachment security increases acceptance (Study 1: n = 173) and perceived responsibility toward anthropogenic climate change (Study 2: n = 209) via increased empathy for others. Next, we demonstrate that priming attachment security, compared to a standard National Geographic video about climate change, increases monetary donations to a proenvironmental group in politically moderate and conservative individuals (Study 3: n = 196). Finally, through a preregistered field study conducted in the United Arab Emirates (Study 4: n = 143,558 food transactions), we show that, compared to a message related to carbon emissions, an attachment security–based message is associated with a reduction in food waste. Taken together, our work suggests that an avenue to promote climate change mitigation could be grounded in core ethological mechanisms associated with secure attachment.

attachment | climate change | food waste

The negative effects of climate change are looming, demanding forceful and immediate action from multiple stakeholders, including households and individuals. Despite the pressing need for climate change mitigation, many people still deny the reality or seriousness of climate change (1). Furthermore, even when people do acknowledge climate change, they often do not change their behavior in substantive ways to reduce carbon emissions (2). Several reasons have been proposed to explain the limited household action to mitigate climate change (3), and among alternative accounts, the hypothesis of motivated reasoning is gaining momentum. The motivated reasoning hypothesis proposes that limited action on climate change may function to safeguard core identity motives, ideologies, and worldviews, including perceived conflicts between mitigating climate change and maintaining economic prosperity (4). This perspective is increasingly prominent in the literature, particularly with research suggesting that individuals construe scientific evidence about climate change in ways that are self-serving (5). Therefore, given that attitudes and action about climate change are, at least partially, influenced by motivational processes, the question remains of how to motivate individuals toward more proenvironmental pathways.

We propose that climate change mitigation may be promoted when psychological structures related to human interconnection are developed and active. This is based on the premise that the willingness to mitigate climate change involves accepting human (co)accountability, caring for others (present and future generations), and a readiness to act (together) as a mitigation response.

Here, we specifically examine the role of attachment orientation in the willingness to mitigate climate change, in line with increasing calls to invest in demand side solutions to address global warming (6). We focus on attachment because it relates to the primal form of emotional bonding between humans (7). From an evolutionary perspective, attachment is conceptualized as an innate behavioral system aimed at safeguarding against

potential threats by assuring proximity to caring and supportive others (8). The motivation to seek proximity to protective others is functionally different from more general affiliation needs (9); it aims to establish a secure base, which is defined as a sense that protective others are available and responsive in case of threat. This concept of protection from threat is pertinent to climate change because global warming poses an existential threat to humankind, which is within the realm of stimuli that could be expected to activate the attachment system.

Researchers have identified two primary attachment orientations* (10–12): a secure attachment orientation, which is used to describe people who have experienced a sense of safe haven, protection, and comfort from close others in times of distress, and an insecure attachment orientation, which is associated with experiences of being rejected or ignored by close others in times of need or threat (13).

This distinction between attachment orientations is significant because the attachment system is linked to other behavioral systems (14), namely the caregiving system. The caregiving system is thought to have evolved to provide protection and support to others, and is inherently altruistic in nature (15). These behavioral systems are linked in a way that, when people feel comforted and safe in threatening situations (securely attached), the activation of caregiving is facilitated, enabling them to focus on the distress of others (16). By comparison, insecurely attached

Significance

Attachment theory focuses on the primal form of emotional bonding between humans. Attachment is conceptualized as an innate behavioral system aimed at safeguarding against potential threats by assuring proximity to caring and supportive others. When individuals feel securely attached (thus feeling less threatened in most situations), the activation of the caregiving behavioral system (concern for others) is facilitated. With this research, we show that priming attachment security influences how much people care about and accept climate change via an increased empathy for humanity. Furthermore, we demonstrate that this activation bypasses the resistance of politically conservative individuals to mitigate climate change. Overall, we show that attachment security–based stimuli can inform intervention and policymaking strategies to help fight climate change.

*There are several conceptualizations of different subcategories of insecure attachment (e.g., ref. 13), but our goal in this paper is to examine the effect of secure (versus insecure) attachment and not to examine the implications of distinct forms of insecure attachment for climate change mitigation.

individuals tend to remain focused on their own distress and are less likely to engage in altruistic behaviors. Only when relief from threat is achieved, and a sense of safety restored, can individuals shift resources to other behavioral systems such as caregiving (17). Thus, attachment security does not activate the caregiving system directly but rather offers a solid psychological foundation for altruism (18). Previous research has shown the positive impact of secure attachment in multiple instances of caregiving, including volunteering and helping behavior (18, 19). Essentially, secure attachment, as a basic psychological need related to safety and protection, anchors the progression toward higher-level psychological processes (19) and offers a strong, theoretical foundation to understand prosocial behavior. In prior research, mitigating climate change has been defined as a form of prosocial behavior, which places individual self-interest behind the collective welfare (20).

The interplay between the attachment and caregiving systems has several important implications for research about climate change. First, attachment theory sheds a different light on prosocial behavior, examined through an evolutionary perspective. Research based on evolutionary frameworks suggests that prosocial behavior occurs primarily to protect reputation and build reciprocity as a means to guarantee return benefits, particularly from in-group members (21, 22). However, the distinctiveness of the attachment system lies in the ethology of the bonding process, which goes beyond the notion of transactional social ties. Seminal evidence from humans and nonhuman primates (23, 24) has shown that the attachment system is not rooted in reward reinforcement from the caregiver (such as food) but rather is motivated by a need for protective bonding. Secure attachment has been linked to volunteering and helping behavior (which are features of the caregiving system) beyond the boundaries of close in-group members—for example, toward strangers and unrelated individuals (14–18).

Second, secure attachment may be the psychological infrastructure on which several factors previously associated with caring for the environment are built. There is evidence showing the role of altruistic social orientation, empathy, and universality values in proenvironmental behaviors (25–27). This previous research, however, leaves unaddressed what promotes these factors. We propose that attachment security is a crucial, latent foundation because of its facilitating role in the activation of the caregiving system, which offers a broader conceptual perspective to previous findings.

Third, the literature on adult attachment theory provides a validated, experimental apparatus for the design of interventions (18) to increase the manifestation of prosocial behavior. A core assumption in attachment theory is that attachment orientations are relatively stable over time (12) but prone to temporary variations (e.g., such as a parent's death, a job loss, or a new intimate relationship) and transient fluctuations, including experimental manipulations (14). There is consistent causal evidence showing the effect of priming attachment security in increasing levels of empathy, trust, and helping behavior (11, 15, 18). Therefore, such validated, experimental manipulations also allow one to experimentally test the effect of attachment security on beliefs and action toward anthropogenic climate change.

Finally, attachment theory is not culturally bound, unlike other perspectives on climate change (28). A central feature of attachment theory is the universality of its premise (7), with minor cultural variations (29). Fundamentally, attachment security is a psychological feature that can be nurtured in all humans. Given its link to a generalized concern for others' welfare (14), attachment security could help the conservation of global public goods (20) that require protective action based on common concerns that affect all of humankind—of which climate change is a paradigmatic example.
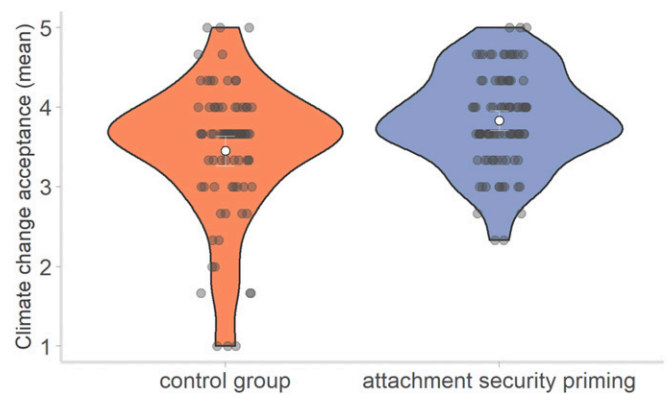

Fig. 1. Acceptance of anthropogenic climate change per condition (Study 1).

Results

Overview of Studies. This paper reports the results from four studies. Study 1 establishes the causal link between attachment security and the acceptance of anthropogenic climate change. Study 2 tests a replication of this effect and examines two potential mediating mechanisms (trust and empathy) between secure attachment and climate change mitigation. Trust and empathy are both relevant for climate change research (25, 26), and both have been shown to originate in feeling securely attached (7, 18, 30). Regarding trust, securely attached individuals may trust others not to free ride and to abide by shared norms to fight climate change. As for empathy, it may increase the concern toward the distress and insecurity that climate change may bring to humanity. In Study 3, we compare the impact of priming attachment security to a climate change video from National Geographic—a standard communication strategy. Specifically, we examine whether attachment security priming—a stimulus unrelated to knowledge about climate change—can increase the willingness to donate to a proenvironmental group to the same extent as a standard climate change video presenting factual information about global warming. Moreover, we analyze whether political ideology, a consistent factor in proenvironmental attitudes (31), moderates the effect of the experimental manipulations on monetary donations. Finally, Study 4 examined whether an attachment security–based message would reduce food waste in a naturalistic setting, compared to either a message about the carbon emissions produced by food waste or to no message. This preregistered field study was conducted in the cafeteria of an international university, which comprises students and staff of 130 nationalities.

Study 1: Secure Attachment Predicts Acceptance of Anthropogenic Climate Change. Participants ($n = 173$) were randomly assigned to a control group or a secure, attachment-priming group (details about experimental stimuli, manipulation check, and outcome measures in *Materials and Methods*). Mean differences between groups showed that priming secure attachment significantly increases individuals' acceptance of anthropogenic climate change [$M_{control} = 3.90$, $SD_{control} = 1.13$, $M_{priming} = 4.26$, $SD_{priming} = 0.69$, $F(1, 171) = 6.49$, $P = 0.01$, and Cohen's d = 0.39, 95% CI 0.09, 0.69] (Fig. 1). The priming manipulation influenced the acceptance of anthropogenic climate change regardless of participants' baseline attachment orientation. About 54% of participants self-categorized as securely attached ($n = 93$), whereas 46% self-categorized as insecurely attached[†] ($n = 80$), but the interaction between the experimental manipulation and baseline

[†]Insecure attachment: 38.7% self-categorized as avoidant ($n = 67$) and 7.5% self-categorized as anxious ($n = 13$).

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attachment orientation was not significant [experimental manipulation × baseline attachment orientation $F(3, 169) = 0.41 P = 0.52$].

Study 2: Secure Attachment Predicts Perceived Responsibility about Anthropogenic Climate Change via Increased Empathy for Others. Participants ($n = 209$) were randomly assigned to a control group or a secure, attachment-priming group (details about experimental stimuli, manipulation check, mediators, and outcome measures in *Materials and Methods*). The priming of attachment security directly increased the perceptions of personal responsibility about climate change ($M_{control} = 5.14$, $SD_{control} = 1.46$, $M_{priming} = 5.49$, $SD_{priming} = 0.92$, and $P = 0.04$; Cohen's d = 0.28, 95% CI 0.01, 0.55).

Regarding the mediators under analysis, priming attachment security did not significantly increase trust (composite measure $\alpha = 0.85$; $M_{control} = 4.16$, $SD_{control} = 1.16$, $M_{priming} = 4.44$, $SD_{priming} = 1.17$, and $P = 0.08$; Cohen's d = 0.25, 95% CI −0.03, 0.52). We additionally conducted more granular analyses to examine further whether some specific dimensions of trust could have been influenced to a greater extend. Results per item show that "trust in all people" almost reached significance (B = 0.44 and $P = 0.07$) but "trust in people from my community" (B = 0.29 and $P = 0.14$) and "trust in government/public institutions" (B = 0.32 and $P = 0.17$) did not. Of note, the latter two items have often been proposed as critical trust dimensions to understand the support for climate change action (32). However, attachment security–induced trust does not seem to extend to public institutions.

In contrast, priming attachment security significantly increased empathy (composite measure $\alpha = 0.76$; $M_{control} = 3.79$, $SD_{control} = 0.82$, $M_{priming} = 4.04$, $SD_{priming} = 0.64$, and $P = 0.02$; Cohen's d = 0.34, 95% CI 0.07, 0.61). Furthermore, path analysis indicated that there was a significant indirect effect between attachment security and personal responsibility about climate change via empathy (B = 0.25, 95% CI 0.07, 0.48, and $P = 0.01$) but not via trust (B = 0.07, 95% CI −0.003, 0.23, and $P = 0.07$). This mediation via empathy offers support for the hypothesis that attachment security allows for the activation of the caregiving system. These results from path analysis revealed that the hypothesized model fit the data very well [$\chi^2 (1, n = 209) = 0.07$, $P = 0.79$, root-mean-square error of approximation = 0.00, standardized root-mean-squared residual = 0.00, comparative fit index = 1.00, and incremental fit index = 1.00]. There were no modification indices suggested for this model, and CI estimates were calculated using bias-corrected 95% bootstrapping.

Study 3: Secure Attachment Predicts Proenvironmental Donations Regardless of Political Ideology. Participants ($n = 196$) were randomly assigned to a control group, a National Geographic video about climate change group, or a secure, attachment-priming group (details about experimental stimuli, manipulation check, and outcome measures in *Materials and Methods*). We started by using logistic regression to examine the impact of each experimental manipulation in the likelihood to donate, testing the factors "Climate Change Video" (1 = National Geographic video; 0 = otherwise) and "Secure Attachment Priming" (1 = Priming manipulation; 0 = otherwise). Logistic regression results showed that the likelihood to donate per experimental group significantly differed compared to the control group (49.1%): The climate change video group did not reach significance (65.7% odds ratio [OR] = 1.39, 95% CI 0.99, 1.96, and $P = 0.06$), but the secure, attachment-priming group significantly increased the odds of donation (66.7%; OR = 1.42 95%, CI 1.00, 2.00, and $P = 0.05$). Thus, compared to no stimulus, priming attachment security—without any reference or information about the environment—increases the donations to a proenvironmental group more than a standard climate change video. However, the two experimental groups are not statistically different [$\chi^2 (1, n = 139) = 0.01$ and $P = 0.91$].

We ran a second model including political ideology as a main covariate. Political ideology per se was not a significant predictor of the likelihood to donate ($\beta = 0.01$, $P = 0.95$, OR = 1.01, and 95% CI 0.72, 1.42) nor did it change the results per experimental group (priming attachment security group $\beta = 0.42$, $P = 0.04$, OR = 1.51, and 95% CI 1.01, 2.26; climate change video group $\beta = 0.23$, $P = 0.26$, OR = 1.25, and 95% CI 0.85, 1.85).

We then used a logistic regression model to test whether the main effects of the two experimental manipulations ("Climate Change Video" and "Secure Attachment Priming) interacted with political ideology. The results are displayed in Fig. 2. Examining the interaction effect between political ideology and each of the experimental manipulations showed that there was no significant interaction between priming attachment security and political ideology to predict likelihood to donate (Fig. 2*A*; $\beta = −0.09$, SE = 0.21, and $P = 0.67$), but there was a significant interaction between exposure to the climate change video and political ideology (Fig. 2*B*; $\beta = −0.39$, SE = 0.21, and $P = 0.06$). Therefore, we found that attachment security priming creates a higher rate of donations among both liberals and conservatives, whereas the information video making a case for reducing climate change appeared to backfire for conservatives.

For the amount donated, we conducted a linear regression also using the factors "Climate Change Video" (1 = National Geographic video; 0 = otherwise) and "Secure Attachment Priming" (1 = Priming manipulation; 0 = otherwise) as independent variables. Results showed no significant differences per experimental condition compared to the control group (climate change video $\beta = 0.06$ and $P = 0.48$; secure attachment priming $\beta = 0.06$ and $P = 0.47$). The average amount donated in the control group was $0.09, $0.11 in the climate change video group, and $0.11 in the secure, attachment-priming group. There was also no significant interaction between political ideology and the experimental manipulations to predict the amount donated.

Study 4: Secure Attachment–Based Field Intervention Is Associated with Reduced Food Waste. This was a field study (33) that was preregistered before receiving the data and conducting the analysis. The study was conducted in the cafeteria of an international university based in the United Arab Emirates, which comprises students and staff of 130 nationalities. This cafeteria offers a daily free three-meal plan to students (breakfast, lunch, and dinner). It also provides the same meal options to staff and other visitors subject to payment. The catering provider provides about 2,000 meals per day and monitors daily the food waste produced at the consumer level.

In this study, we implemented a multiple treatment reversal design (MTRD). MTRD is a quasiexperimental research design that alternates the introduction of different treatments (34). A baseline phase (no intervention) is followed by the introduction of a treatment for a period of time, which is then subsequently removed. After this period of withdrawal (no treatment), a new treatment is introduced for a period of time and subsequently also removed (Fig. 3*A*). This design was selected because of the impossibility to randomly allocate participants to different treatments, in the context of a university cafeteria, without interfering with regular operational activities.

The study ran for nearly 3 mo and was comprised of different phases (Fig. 3*A*). A baseline period (3 wk) occurred with no intervention. Next, an intervention period (4 wk) was implemented, during which we introduced and removed intervention A and intervention B on different days. Intervention A portrayed the contribution of food waste to carbon emissions, and intervention B portrayed an attachment security–based image of Mother Earth (extensive pretest and piloting of banners detailed in *Materials and Methods*). Intervention A was introduced for 4 d and then removed for 4 d. Intervention B was then introduced for 4 d and then also removed for 4 d. This procedure was
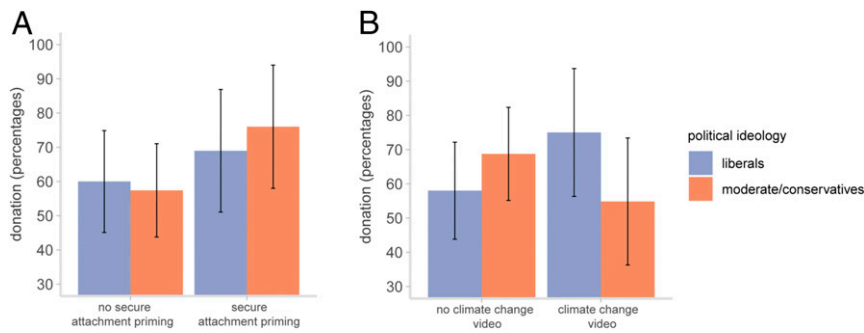
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Fig. 2. Interaction effect between political ideology and priming attachment security (*A*) versus exposure to a climate change video (*B*) in the likelihood to donate (Study 3).

repeated twice, and the overall average exposure to each intervention was 8 d (Fig. 3*B*). Both intervention A and intervention B were a pair of identical banners positioned at the entry of the cafeteria, one on each side of the entrance door (Fig. 3*C*). The study concluded with a follow-up period (4 wk), during which no intervention was implemented.

The baseline period comprised 40,270 food transactions, producing 2,125 kg food waste. This corresponded to an average 0.053 kg food waste per food transaction (SD = 0.006) during the baseline period, a proxy for average food waste per capita.

During the intervention period, when the carbon emissions banners were exposed (intervention A), average food waste per capita was 0.057 kg (SD = 0.01; total 11,827 food transactions; and 674 kg total food waste). This was similar to the baseline period (Mann–Whitney *U* test = 1.65 and *P* = 0.10) but suggesting a tendency toward higher waste.

In contrast, when the Mother Earth banners were exposed (intervention B), average food waste per capita was 0.050 kg (SD = 0.004; total 13,195 food transactions; and 660 kg total food waste), significantly lower than when the carbon emissions banners were exposed (Mann–Whitney *U* test = −2.17 and *P* = 0.03) (Fig. 4). Moreover, compared to all other periods, the aggregate days displaying the Mother Earth banner show the narrowest interquartile range (Fig. 4), suggesting less dispersion and variability in behavioral patterns leading to food waste. However, the amount of food waste on days when the attachment banner was present did not differ from the amount of food waste measured at baseline. While there was a trend—the attachment banner seemed to be associated with less food waste—it was not statistically significant (Mann–Whitney *U* = −1.43 and *P* = 0.16).

The follow-up period had an average lower food waste per capita (mean = 0.047 kg and SD = 0.006; total 40,546 food transactions; and total food waste 1,965 kg) compared to the baseline period (Mann–Whitney *U* test = −2.50 and *P* = 0.01). It was also lower compared to the days exposing the carbon emissions banners (Mann–Whitney *U* test = −2.74 and *P* = 0.006). In contrast, there was no significant difference in food waste between the follow-up period and the days exposing the Mother Earth banners (Mann–Whitney *U* test = −1.25 and *P* = 0.21), suggesting that the sustained effects identified after the intervention was concluded may have derived from the effect of the Mother Earth banners.

Overall, Study 4 reports small effects, even when differences between conditions reach statistical significance. Yet these small reductions per food transaction add to less negligible aggregate effects over time. The university cafeteria registers about 2,000 food transactions per day. A reduction in 0.003 kg per food transaction (the average savings from the attachment banner) corresponds to about 6 kg food waste per day, 180 kg food waste per month, and 2,160 kg food waste per year—assuming that the effects can be sustained over time, something future research should examine further.

Discussion

Attachment theory has been an unexplored factor within the spectrum of individual, demand side approaches to climate change mitigation. This paper fills that gap by establishing that attachment security impacts how much people accept, care, and are willing to endure the costs to mitigate climate change. Specifically, we found that secure attachment predicted an increased acceptance and perceived responsibility about climate change (Studies 1 and 2), a higher likelihood to donate to a proenvironmental group (Study 3), and is associated with reduced food waste (Study 4). Our work offers a comprehensive set of studies, suggesting that efforts to mitigate climate change may be built on, and remain closely connected to, core psychological mechanisms associated with primal, secure attachment.

Why does attachment security seem to produce positive effects toward mitigating climate change? Our results suggest that the activation of caregiving motives, expressed as higher empathy, is the underlying process. Our results are compatible with the hypothesis that secure (versus insecure) attachment tempers self-interest and increases the willingness to endure the costs to finance cooperative solutions to mitigate climate change. We do not claim that only altruistic motives can promote climate change mitigation. There is evidence showing that self-interest motives (e.g., such as saving money) can also be effective in promoting proenvironmental behavior (35). What we argue is that, when attachment security is activated, the path toward climate change mitigation appears to be via a more empathic concern for humanity. Secure attachment binds humans to each other and fosters a sense of psychological connectedness, which appears to be relevant for tackling climate change.

A greater empathic concern for others but not more trust (in others or in public institutions) predicted acceptance and perceived responsibility about anthropogenic climate change. This is a crucial finding, because the tragedy of the commons (36) conveys the notion that personal and social interests are at odds, and most solutions proposed to solve this dilemma are based on the idea of building social trust. Theories about social capital and trust propose that community members are anticipated to work cohesively in order to protect the public good (37). Free riding on the sacrifices of others to mitigate climate change has been seen as a cornerstone challenge to solving the tragedy of the commons, and social trust based on expected norms and shared resources has been presented as a key solution to overcoming this challenge. There is consistent evidence showing the positive relationship between trust and proenvironmental attitudes (32)—although the vast majority of this evidence is correlational. Our results did not corroborate the positive effect of trust on climate change mitigation and suggested that empathy may be a better (complementary) alternative. Given the evidence that the attachment system transcends the boundaries of ingroup favoritism and generalizes to facilitating empathy and caring beyond
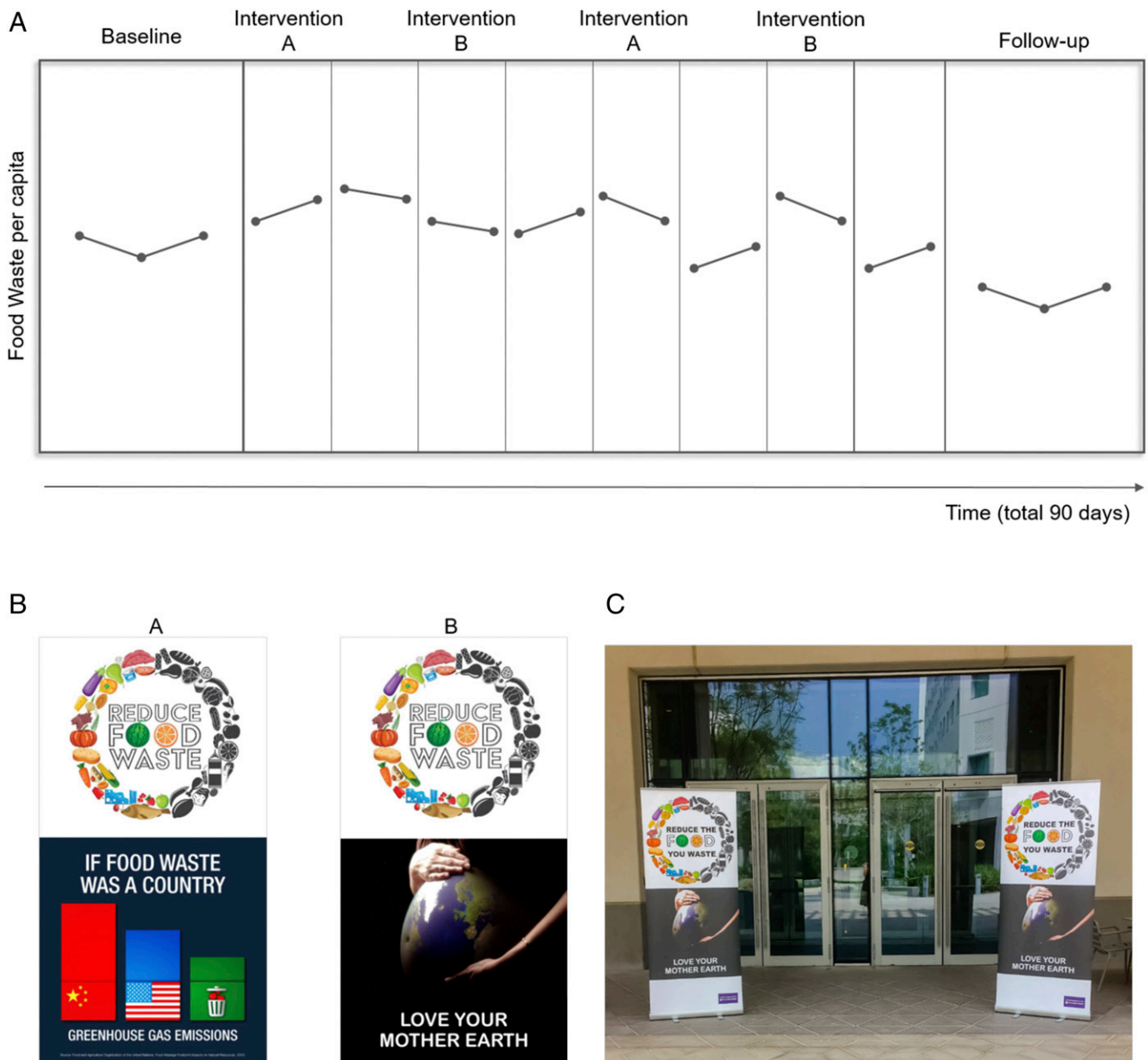
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Fig. 3. Composite panel of Study 4. Schematic presentation of the research design (*A*); banners used as intervention A (information about food waste and carbon emission) and intervention B (Mother Earth) (*B*); and illustration of the intervention display at the entry of the cafeteria (*C*). Each intervention period corresponded to a pair of identical banners (either intervention A or B).

the circle of close social groups (11, 14, 18), an intervention based on attachment security may be more resistant to concerns about free riding, because it is less based on expectations of reciprocity. However, a possible explanation for why trust was not a significant predictor in our study could be the lack of strategic action. Our work did not include coordination or a game-theoretical setting, with multiple players deciding and acting in parallel. Trust may be a stronger predictor of climate change mitigation when the strategic nature of the situation is more salient (38). Future research should examine whether attachment security (both dispositional and experimentally manipulated) could support cooperation in strategic games that mimic environmental dilemmas, such as common-pool resources dilemma, in which participant's behavior has direct and more visible consequences for other players, often in multiple rounds of decisions.

Crucially, our work calls attention to the importance of understanding the motivational power of the stimuli used when developing interventions to change behavior about climate change. The most common strategies to promote climate change mitigation involve providing factual information, risk statistics, or carbon footprint messages. However, these strategies tend to produce minimal effects (39). We corroborate this previous evidence by showing that an attachment security–based stimuli is more effective in promoting proenvironmental behavior than standard informational messages (such as a National Geographic video about climate change or a banner emphasizing the carbon emissions produced by food waste). These results are not entirely surprising. Information-based stimuli are, on average, less effective than often assumed (39). Furthermore, there is evidence that showing informational stimuli may actually backfire, a
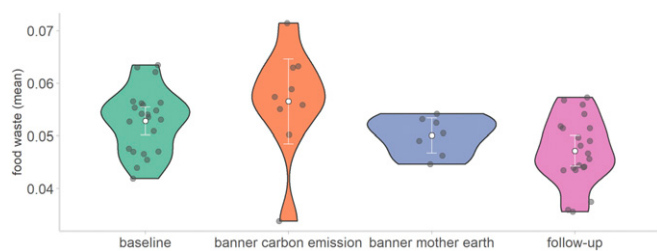
Fig. 4. Average food waste per capita during the days when different banners were present (Study 4). In the baseline and follow-up periods, there was no intervention (i.e., no banners).

phenomenon attributed to psychological reactance (40, 41). Whereas limited information may impair the understanding of climate change, more information does not necessarily promote action on climate change. A secure attachment priming would have been unlikely to significantly change participants' views, if their belief or denial of climate change was based solely on factual evidence (or lack thereof).

The current results also suggest that future research should examine whether information about climate change (delivered via education, videos, leaflets, public service announcements, or fundraising campaigns) could potentially benefit from being paired with attachment security stimuli. Whether combinations of stimuli work as substitutes (competing effects; negative interaction) or as complements (synergist effects; positive interaction) is a very important debate and a topic that warrants further research. Although combinations of stimuli may create expectations of better effects, the evidence is unclear (42, 43). Therefore, combining intervention stimuli may not be necessarily better, but it is worthy of rigorous testing.

Furthermore, experimental manipulations of attachment security show that it is possible (at least momentarily) to influence the extent to which people acknowledge climate change and their responsibility toward it. This was true independent of both information and political ideology. For instance, the effect of secure attachment priming on the likelihood of donating to a proenvironmental group was the same for people from different political ideologies. In contrast, the climate change video increased the likelihood of donation to a proenvironmental group in liberals but not in conservatives. Thus, a key to engaging conservatives in climate change action may be to elicit prosocial motivations and rely less on education about climate change. Moreover, a value system that climate change deniers have been shown to protect is the capitalist socioeconomic system (4). Individuals motivated to protect the status quo over fears of economic instability tend to downplay climate change. Attachment security and empathy have been shown to reduce materialist attitudes and concern over material possessions (44), which could be a possible route to reduce climate change denial. The well-documented reactance effects to informational advice (40, 41), in addition to the known resistance from conservative individuals to data about climate change (31), make the relative positive effects of attachment security—a stimuli without any mention to facts and figures—all the more significant.

Taken together, our results suggest that climate change mitigation efforts should be focused on human–human interconnection. Many standard climate change messages address human connection, yet attachment security is not about general human connection. Rather, it is specifically about infant–caregiver or protectee–protector connection. Changing dispositional attachment security likely takes long-term structural and institutional changes to produce results, mainly in the groups through which people fulfill their basic human needs (45). Nonetheless, developing family and childcare policies that focus on secure attachment would not only improve psychological wellbeing in childhood

(7) but could also produce positive collateral effects into adulthood, including proenvironmental attitudes and behaviors. Moreover, in tandem with investing long term in secure attachment, shorter-term gains can be achieved by incorporating attachment security stimuli in interventions designed to mitigate climate change. A powerful way to elicit this effect may be by using child–mother bonding stimuli. Our work shows that individuals with both secure or insecure dispositional attachment respond positively to such stimuli, and thus, this approach is not restricted to certain groups of individuals. Our results suggest that these simple cost-effective interventions, implemented on a larger scale, could contribute in nonnegligible ways to advancing climate change mitigation efforts.

In particular, findings from Study 4 suggest that secure attachment stimuli could be successfully translated into field interventions. Nonetheless, caution is warranted. In nonrandomized designs such as Study 4, causality cannot be clearly established. We proposed the hypothesis that the sustained effects may have derived from the attachment banners, but this is a hypothesis that still requires more rigorous causal testing, and results should be interpreted prudently. Study 4 offers promising evidence that attachment security–based stimuli may be translated to the field and produce positive effects—above more traditional, informational stimuli.

Some limitations of this work should be discussed. First, our decision to use the categorical measure of attachment orientation by Hazan and Shaver (46) has received criticisms, with some arguing that other continuous measures [such as Experience in Close Relationships (ECR) (13)] have been shown to be more reliable. The primary goal behind using Hazan and Shaver's measure was to achieve a parsimonious and simple categorization between secure versus insecure attachment. Although there may be differences between different insecure attachment orientations (like anxious or avoidant) with respect to proenvironmental action, our main focus was restricted to attachment security (versus otherwise), in line with several previous papers (14, 18). However, for the manipulation check, which was examined as mean differences in attachment security between the control and experimental group, we used the ECR measure. Second, both Hazan and Shaver (46) and ECR (13) measure trait attachment. Although conceptually it is more rigorous to use state measures when assessing the effect of experimental manipulations (and future research is advised to do so), the items in state and trait attachment measures are not substantially different (47). Although the state versus trait measures are based on distinct conceptual assumptions, the items used to assess attachment security are very similar. Only two items out of the seven included in the state measure (47) actually allude to the "right now" state. All other items have similar wording to the items used in the ECR trait measure. Therefore, it seems plausible to assume that similar results would have been obtained with a state measure.

Potential limitations notwithstanding, this work opens promising avenues for future research. First, our results show the significant impact of attachment security controlling for political ideology. However, future research should also examine concepts like right-wing authoritarianism (RWA) or social dominance orientation (SDO), both of which have been shown predictors of proenvironmental attitudes (26, 31). This could be an important avenue to pursue, because both RWA and SDO have also been proposed to stem from parent–child relationships (48), and there is evidence that both concepts are related to insecure attachment (49). Thus, attachment (in)security may also be a key determinant of RWA and SDO that underlies the strong association with proenvironmental attitudes. Second, future research should also extend the analysis of the impact of secure attachment stimuli over time in naturalistic situations. How long can an attachment security stimulus sustain proenvironmental behavior?

Finally, an additional point that this work did not examine was whether attachment security increases caregiving and empathy

for nonhuman entities like fauna and flora. Currently, our results suggest that concerns about climate change are rooted in caring for other people. However, future research should address whether an experimental, secure attachment priming could produce a greater concern for all living creatures and not only for humans. There is the possibility that priming attachment security could also increase empathy for animal welfare and the preservation of natural resources, which could also lead to a higher acceptance and willingness to mitigate climate change. This could imply that the fundamental ability to bond and care for others is a pathway to bond and care for the environment (50).

Materials and Methods

Study 1.

Sample. Participants were recruited via TurkPrime (51), a third party between researchers and MTurk—Amazon's crowdsourcing platform in which individuals can accept tasks (such as surveys) in exchange for payment. We restricted participant selection to United States locations, with some experiences (more than 50 tasks completed) and with good past performance (over 98% approval rate in previous tasks). Participants were paid $1 USD for participating in the study. Power calculations for this experimental study with two groups, assuming a small-to-medium effect ($f = 0.15$) and 80% power (52), suggests a sample of 166 participants. We recruited a total of 173 participants (58% female, $M_{age} = 39.1$, and $SD_{age} = 12.1$; education: 42.5% high school/ some college and 57.5% college degree or above; income: 50% up to $50,000 USD and 75% up to $70,000 USD; employment: 66.7% employed full-time; marital status: 57.8% married; and ethnicity: 78.7% White).

Measures and procedure.

Baseline attachment orientation. Baseline attachment was measured using the measure from Hazan and Shaver (46). Attachment orientation was measured with this well-validated, categorical measure in which individuals self-categorized in the main attachment orientation that describes their dominant orientation toward interpersonal relationships. This measure was collected to examine whether the experimental manipulation was moderated by the baseline (dispositional) attachment orientation of participants. Participants were asked the following multiple-choice question: "Which of the following statements best describes how you feel most of the time?"

"I find it relatively easy to get close to others and am comfortable depending on them and having them depend on me. I don't worry about being abandoned or about someone getting too close to me" (Secure).

"I am somewhat uncomfortable being close to others; I find it difficult to trust them completely, to allow myself to depend on them. I am nervous when anyone gets too close, and often, others want me to be more intimate than I feel comfortable being" (Insecure Avoidant).

"I find that others are reluctant to get as close as I would like. I often worry that people don't really love me or won't want to stay with me. I want to get very close to others, and this sometimes scares people away" (Insecure Anxious).

Experimental manipulation. Attachment security manipulations aim to activate a perception of threat (psychological or physical), followed by a scenario in which close protective others respond actively to reduce this threat. Attachment security priming temporarily activates a sense of attachment security, such that cognitions, emotions, and behavior become aligned with a secure attachment orientation (53). We follow the experimental procedure by Mikulincer et al. (14) that primes attachment security using recall narratives about supportive contexts and caregivers (versus a neutral context).

Attachment security condition. "In the following section, we'd like you to think about a recent and important event in your life where you were in a problematic situation. Recall a time when you were surrounded by people who loved you, were sensitive and responsive to your distress, and protected you. As a result, you felt secure. Describe the background, the incident itself, and the consequences—the full story."

Control condition. "In the following section, we'd like you to think about a recent event in your life. Recall a time when you had to go pick up something at the supermarket or grocery store. Describe what you did and the steps you had to take to do that. Describe the background, the event itself, and the consequences—the full story."

Manipulation check. The manipulation check test included both a measurement of attachment orientation and effect. The manipulation check test was performed after the experimental manipulation in the two conditions. The attachment orientation was evaluated using a continuous measure from Fraley et al. (13) about the ECR—General Orientation, including four items such as "I find it easy to depend on other people" and "It helps to discuss things over with people" (1 = strongly disagree to 7 = strongly agree). Total scores of attachment security per participant were computed by using the reverse items about avoidance and anxiety, which were averaged ($\alpha = 0.77$).

Positive and negative affect was measured using the Positive and Negative Affect Schedule items from Watson et al. (54): "Indicate the extent you are feeling this way at this moment" (1 = very slightly or not at all to 7 = a lot) (e.g., interested and excited [positive affect] [$\alpha = 0.81$]; distressed and upset [negative affect] [$\alpha = 0.83$]).
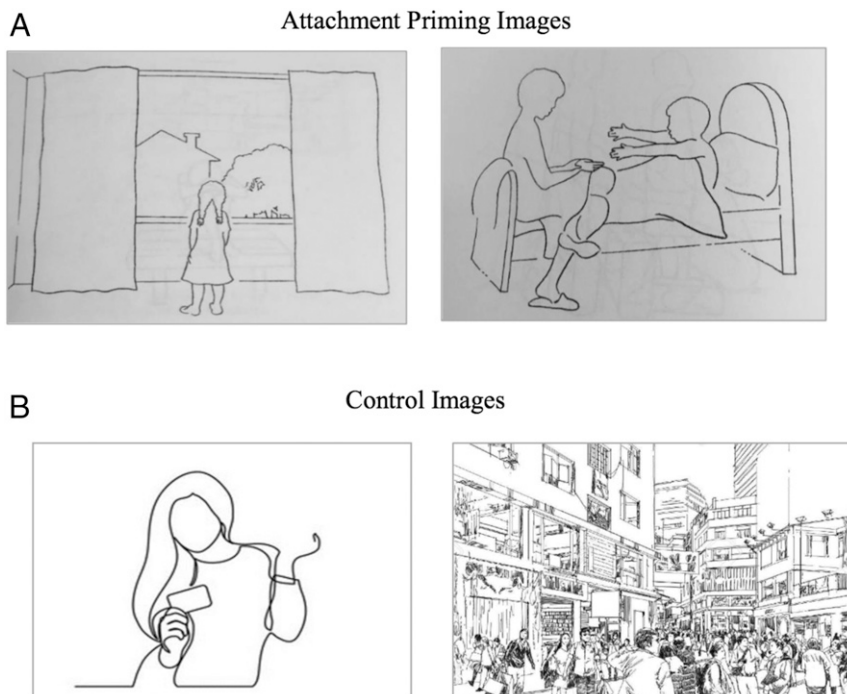
Fig. 5. Images used for the experimental priming manipulation (Study 2): (*A*) attachment priming images; (*B*) control images.

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Outcome. Acceptance of the existence of climate change was measured using two items adapted from the Organisation for Economic Co-operation and Development Greening Household Survey (OECD) (55): "Every time we use coal, oil, or gas, we contribute to climate change" and "Climate change is happening and caused by human activity" (1 = definitely false to 5 = definitely true) ($\alpha = 0.88$).

Manipulation check results. Univariate ANOVA showed that the experimental group reported higher levels of attachment security [$M_{control} = 3.61$, $SD_{control} = 1.31$, $M_{priming} = 4.10$, and $SD_{priming} = 1.54$; $F (1, 171) = 4.26$ and $P = 0.04$]. Thus, the experimental manipulation was successful. Further manipulation checks showed that there were no significant differences in positive affect between the control and experimental group [$M_{control} = 4.68$, $SD_{control} = 1.48$, $M_{priming} = 4.51$, and $SD_{priming} = 1.39$; $F (1, 171) = 0.59$ and $P = 0.44$]. However, participants in the experimental group reported lower levels of negative affect [$M_{control} = 1.99$, $SD_{control} = 1.28$, $M_{priming} = 1.58$, and $SD_{priming} = 1.03$; $F (1, 171) = 5.33$ and $P = 0.02$]. We conducted a regression analysis, with acceptance for climate change as a dependent variable and negative affect and experimental manipulation as factors. The model showed that priming secure attachment significantly increased the acceptance of climate change ($B = 0.38$, $SE = 0.14$, and $P = 0.01$), but negative affect did not predict changes in the acceptance of climate change ($B = 0.06$, $SE = 0.06$, and $P = 0.37$).

Study 2.

Sample. Participants were recruited as in Study 1 via TurkPrime and under the same conditions. Power calculations for this experimental study with two groups and two mediators, assuming a medium effect (as per the effect size in Study 1) and 80% power (52), suggests a sample of 199 participants. We recruited a total of 210 participants randomized according to a 1:1 allocation ratio (42.7% female, $M_{age} = 34.3$, and $SD_{age} = 9.2$ and education: 50.2% up to high school/some college and 49.8% college degree or above).

Measures and procedure.

Experimental manipulation. We developed an experimental procedure in which we used pictures that elicit supportive caregiving contexts, as previously suggested in the literature [e.g., Mikulincer et al. (14)], based on the Adult Attachment Projective Picture System (AAP) (56). The AAP provides validated pictures to elicit narratives of adult attachment. The AAP is comprised of hand-drawn pictures depicting events that, according to attachment theory, activate the attachment system (such as separation and solitude). We provided, as stimuli, the pictures as well as short explanations about the pictures. The explanations were adapted from narratives made by securely attached individuals when presented with these pictures (56). Participants in the control group were exposed to two pictures about neutral, daily experiences in urban settings. Pictures and explanations in the control condition were developed by the authors. All participants were shown two sets of pictures (Fig. 5 *A* and *B*). Participants were randomly allocated to a set of pictures, corresponding to the control group or the experimental group.

For each picture, participants were asked to write their thoughts and feelings about the image. Next, they were shown a short narrative explaining the picture. The images, together with the standard narratives, provided homogenous priming to participants. Participants were shown the following text:

"This next section is about visual perception. There are no right or wrong answers. This is just about your perception. You will see a picture below. What do you think is happening in this picture? What is the situation that comes to your mind? Please give us some details about what you are thinking and feeling."

After participants wrote their text, they were then shown a standard text according to their experimental condition.

Attachment priming group (image left side). "Thank you for your thoughts. We can tell what this scene is all about. This is an image taken from a book about 'Happy Childhoods.' This little girl, Claire, is very happily waiting for her mother and father. Today is Claire's birthday and her parents are almost arriving home to take her to the playground and then for ice cream. Her parents are very happy for her and will give her a new doll as a birthday gift."

Attachment priming group (image right side). "Thank you for your thoughts. We can tell what this scene is all about. This is an image taken from a book about 'Family Ties.' It represents the bonds that are developed between family members from childhood onward, particularly the protection of parents toward their children."

Control group (image left side). "Thank you for your thoughts. We can tell what this scene is all about. This is an image that exemplifies a psychological effect called 'Choice Overload.' For example, credit cards allow us to choose and buy so many similar products, when in fact it is often easier to buy if you have less choices available to you. Marketing strategies would be more successful and would sell more products if focused on less options."

Control group (image right side). "Thank you for your thoughts. We can tell what this scene is all about. This is an image that exemplifies the modern lifestyle lived in many major cities around the world. People live in a world with a variety of products and services available to them."

Manipulation check. The experimental manipulation as evaluated using the ECR measure ($\alpha = 0.76$) (13), positive affect ($\alpha = 0.67$), and negative affect ($\alpha = 0.76$) (54), as in Study 1.

Outcome. We included items taken from Steg et al. (57). Four items including proenvironmental personal norms ($\alpha = 0.90$) (e.g., "I feel personally obliged to save as much energy as possible" and "I feel morally obliged to save energy, regardless of what others do"), as well as the same number of items related to ascription of responsibility about climate change (e.g., "I feel jointly responsible for global warming" and "I am jointly responsible for the energy problems") (1 = strongly disagree to 7 = strongly agree).

Mediators. For trust, we used five items adapted the World Values Survey (58). Trust can be conceptualized at multiple levels, and we included the following items: "Generally speaking, would you say that _____ can be trusted 1) your family/ friends, 2) people from your community, 3) people from your country, 4) all people, and 5) the government/public institutions (1 = strongly disagree to 7 = strongly agree) ($\alpha = 0.85$).

Empathy was measured using six items taken from Sprecher and Fehr's measure of empathy for strangers-humanity (59) (e.g., "I feel a selfless caring for most of humankind" and "I often have tender feelings toward strangers when they seem to be in need") (1 = does not describe me to 5 = describes extremely well) ($\alpha = 0.76$).

Manipulation check results. Univariate ANOVA was used for the manipulation check, which showed a significant difference between the control and experimental group. The experimental group reported higher levels of attachment security [$M_{control} = 3.83$, $SD_{control} = 1.62$, $M_{priming} = 4.24$, and $SD_{priming} = 1.49$; $F (1, 208) = 3.75$ and $P = 0.05$]. Thus, the experimental manipulation was successful. There were no significant differences between the control and experimental group in positive affect [$M_{control} = 4.72$, $SD_{control} = 1.29$, $M_{priming} = 4.80$, and $SD_{priming} = 1.35$; $F (1, 208) = 0.24$ and $P = 0.63$] nor in negative affect [$M_{control} = 2.44$, $SD_{control} = 1.34$, $M_{priming} = 2.50$, and $SD_{priming} = 1.45$; $F (1, 208) = 0.09$ and $P = 0.76$].

Regarding the outcome measures, two dimensions from Steg et al. (57) were initially measured: personal norms and perceived responsibility about climate change. However, a factor analysis showed items grouped in a single factor (Kaiser–Meyer–Olkin [KMO] Test = 0.69; Bartlett's Test of Sphericity = 701.30 and $P < 0.001$; and cumulative eigenvalue 76.2%) and were thus combined in a composite variable ($\alpha = 0.90$)—designated, perceived personal responsibility about climate change.

Study 3.

Sample. Participants were recruited, as in Studies 1 and 2, via TurkPrime and under the same conditions. Power calculations for this experimental study (three groups, binary outcome), assuming a medium effect (f = 0.25) and 80% power (52), suggests a sample of 155 participants. We recruited a total of 196 participants (46.8% female, $M_{age} = 38.8$, and $SD_{age} = 12.4$ and education: 40.3% up to high school/ some college and 59.7% with college degree or above).

Measures and procedure.

Experimental manipulation. To keep the number of experimental stimuli constant across conditions, all participants were exposed to a video and two images. First, there were two possible videos: a National Geographic video about climate change (60) and a neutral, unrelated video (61). Participants were asked to watch the videos and write a small text afterward explaining what the video was about. Second, there were two possible sets of images (as in Study 2) two images about neutral daily experiences, and two images eliciting the attachment system. The groups were exposed to the stimuli as follows: 1) control group, participants watched the control video and were then exposed to the control images; 2) climate change video group, participants watched the National Geographic video and were then exposed to the control images; and 3) attachment priming group, participants watched the control video and were then exposed to the images eliciting the attachment system.

Manipulation check. As the procedure described in Studies 1 and 2.

Moderator—Political ideology. Political ideology was measured as a continuous variable: 1 = very liberal; 2 = liberal; 3 = moderate; 4 = conservative; and 5 = very conservative (31). This variable was recoded into a dummy variable, 1 = liberals and 2 = moderate/conservative, to perform moderation analysis using a binary moderator.

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Outcome—Donation task. Participants were shown the following message: "You will be paid $1 USD for your answers up to this point. We also have the possibility to offer an additional $0.30 USD as a bonus for your work. You can be paid these additional $0.30 USD or choose to donate this bonus or some part of this bonus. Our research team collaborates with an international university student group called 'ECOherence.' This student group works to disseminate the importance of sustainable lifestyles and promote education and awareness about climate change. Would you be willing to donate some of your bonus in this survey to contribute to 'ECOherence?' We would donate your contribution to the students to support their activities. How much would you like to donate?" Possible answers were the following: 1) $0 USD—nothing; 2) $0.01 USD; 3) $0.02 USD; 4) $0.05 USD; 5) $0.10 USD; 6) $0.15 USD; 7) $0.20 USD; 8) $0.25 USD; and 9) $0.30 USD—all the bonus.

Data analysis. The independent variables in Study 3 were standardized.

Study 4.

Pilot testing of banners. The banners, including the images included and the validity of their content, were pretested in three pilot studies. In the first pilot study (via TurkPrime $n = 289$), we tested 30 images, including images related to 1) mother–child bonding, 2) nature scenarios, and 3) mother–child bonding in nature. Each image was evaluated using five-point Likert scales based on the following questions: "How much does this picture make you feel...loved and protected? Safe and secure? Connected to nature?" The image selected (pregnant woman with an Earth-shaped belly—Banner B) was evaluated the highest on these three items.

Next, we scoped websites from environmental non-governmental organizations and international organizations to identify commonly used images that link food waste with carbon emissions. The assessment popularized by Food and Agriculture Organization (62)—that if food waste were a country, it would be the third-largest emitting country in the world—is used frequently in anti–food waste messaging (e.g., https://twitter.com/faoclimate/status/920969081548951552). Therefore, an image representing this information was selected as the alternative, comparative intervention to attachment security.

Finally, both the carbon emissions image and the attachment security image were composed into banners with a header "Reduce the Food You Waste" (as shown in Fig. 3) and also tested via TurkPrime ($n = 106$). Participants were randomly allocated to see the carbon emissions banner or the attachment security banner. Participants were asked to what extent the banner was...informative? educational? makes you feel loved? makes you feel secure? (1 = strongly disagree to 7 = strongly agree). A factor analysis

resulted in two factors (KMO Test = 0.69; Bartlett's Test of Sphericity = 214.60 and $P < 0.001$; and cumulative eigenvalue 78.1%): The two first items were about information ($r = 0.72$) and the last two about attachment ($r = 0.86$). The banners produced significant differences in these factors. The carbon emissions banner was perceived as more informative [$F (1, 104) = 7.59$ and $P = 0.01$], and the Mother Earth banner increased feelings of attachment security [$F (1, 104) = 3.97$ and $P = 0.05$]. These quantitative measures were corroborated by free-text analysis: Participants were also asked to briefly describe what the banner was about and what message it was trying to convey. After this empirical verification of predictive validity, the banners were printed in large outdoor-size letters (L: 120 cm and H: 300 cm).

Data analysis. The analysis of food waste in the same cafeteria over time poses some challenges. Observations are not independent per se, because the same population tends to use the cafeteria on a daily basis. On the other hand, there is no recordkeeping of which individuals use the cafeteria each day, and the exact same individuals may not be present on a daily basis. Therefore, a nonparametric option such as the Friedman test could not be selected. We ultimately selected the Mann–Whitney U test as our primary statistical test because of the small and unbalanced sample sizes per time period (i.e., the baseline period lasted 21 d, compared to periods of 8 d, each when the banners were exposed). The Mann–Whitney U test does not assume normality in the data but requires homogeneity of variance. This was confirmed with the Levene's test (based on median = 1.38 and $P = 0.23$). Results for differences in food waste per capita in different periods were confirmed with the median test.

We have obtained informed consent from all participants. We obtained ethical approval from the New York University Abu Dhabi internal review board and complied with all relevant ethical regulations for research with human participants. None of our studies involved deception.

Data Availability. The authors declare that the data supporting the findings of this study are available in Open Science Framework (https://osf.io/ja4w6/) (33). All commands used were performed in SPSS Statistics 25, with the path analysis model from Study 3 performed in AMOS Version 21. Analyses may be replicated in R and made publicly available if required by the editorial team or reviewers. All other study data are included in the main text.

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