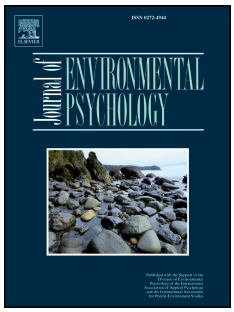
The Email Conservation Task: Testing the validity of an online measure of direct pro-environmental behavior



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The Email Conservation Task: Testing the validity of an online measure of direct pro-environmental behavior

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Abstract

There is a need for valid measures of pro-environmental behavior, in particular ones measuring actual behavior. In response, a number of such measures have been introduced recently, however each faces limitations such as high costs, practical use and/or only measure indirect environmental behavior, limiting their scope, accessibility and inclusivity. In response, this study introduces the easily administered and low-cost Email Conservation Task (ECT), which measures direct pro-environmental behaviour (in this case, email use). Here, participants chose between personal costs (time spent on trivial tasks) or environmental costs (receiving unnecessary emails leading to CO_2 emissions) across multiple trials. In a pre-registered study testing the validity of the ECT, it was found (as hypothesized) that participants scored higher on the ECT (incurred more personal costs rather than receiving unnecessary emails) when personal costs to them were lower, and scored higher when the environmental costs of receiving unnecessary emails were higher. Finally, total scores on the ECT significantly correlated with scores on three self-reported indicators of pro-environmentalism. Overall, the results of this study support all three hypotheses, indicating that the ECT is a valid measure of pro-environmental behavior that can be implemented across a diverse range of research areas.

Keywords: pro-environmental behavior, behavioral measures, email use, online

The Email Conservation Task: Testing the validity of an online measure of direct pro-environmental behavior

1. Introduction

A central challenge for research in environmental psychology is the need to accurately measure pro-environmental behaviour. As a result of this, there currently exists a wide range of measures that have been used in various contexts and paradigms. This was recognised by Lange (2022) in a systematic review, which also highlighted how self-report measures currently dominate research on pro-environmental behavior. However, due to their nature, self-report measures face certain limitations in terms of participant recall and biases (Gifford, 2014). Therefore, there is a need, going forward, for more reliable and valid measures of pro-environmental behavior in future research that can then properly inform real-world applications, with the potential to lead to actual real-world change.

Measures of actual (rather than self-reported) pro-environmental behavior have been recognised as being of the required high standard for future environmental psychological research (Lange, 2022; Lange et al., 2023; Lange & Dewitte, 2019). Such measures can include observing actual pro-environmental behaviour as it occurs naturally, for example turning off car engines when stationary (Meleady et al., 2017), leaving recycling bins for kerbside collection (Gamba & Oskamp, 1994) and reusing hotel towels (Goldstein et al., 2008). However, despite their obvious appeal as natural behaviour, such measures have limitations in terms of the difficulty and costs associated with collecting such data in natural settings, the lack of control, as well as them often being rather crude and ambiguous measures.

Therefore, in order to measure actual pro-environmental behavior in a more controlled manner, researchers have created novel experimental methods to measure this in lab-based settings. For example, experimental paradigms have been developed where financial costs are used to indicate participants' pro-environmental behavior. These include the Greater Goods Game (Klein et al., 2017), which is based on a public goods game which also includes options to donate money to an environmental charity, the Tree Task (Essl et al., 2023) where participants can choose to invest money towards planting a tree, and the Carbon Emission Task (Berger & Wyss, 2021) where participants can choose to invest money towards buying carbon offset vouchers. In these studies, participants who choose not to donate money to the pro-environmental outcomes will instead keep the money themselves. Similarly, a recent study explored the levels of cognitive effort individuals would expend to invest financially in environmental causes compared with their own personal rewards (Krebs et al.,

2023). Therefore, these studies measure the willingness of participants to forgo personal benefits to instead benefit the environment in terms of monetary endowments.

Financial is, however, only one currency in which people can incur costs to help the environment, and other paradigms have used participants' time as a cost in their designs. The Pro-Environmental Behavior task (PEBT) (Lange et al., 2018) requires participants to make a series of sequential choices where personal and environmental costs vary between options. In other words, participants can choose options where the personal costs are low (i.e. faster completion of the task) but the environmental costs are high (a series of LED lights are displayed, leading to unnecessary CO_2 emissions), or vice versa (slower completion of the task, but with no LED lights displayed). Subsequently, the same researchers developed the Work for Environmental Protection task (WEPT) (Lange & Dewitte, 2021) which is similar to the PEBT in measuring time spent as the currency of pro-environmental behavior. The WEPT differs from the PEBT as it runs online, and participants can choose to spend time completing monotonous tasks (counting numbers on a page) in return for money being donated to environmental charities. The WEPT therefore is similar in premise to research on more general prosocial behavior that uses the Free Rice game, where participants spend time completing tasks in exchange for rice being donated to the World Food Programme (Farmer & Farrelly, 2023; Farrelly & Bennett, 2018; Hong et al., 2023).

This range of performance-based experimental protocols have been effectively used to measure pro-environmental behavior, however each have practical limitations that may prohibit more widespread and diverse use. Firstly, they can be costly to use, in terms of the need for specialist equipment (as in the case of the PEBT) or additional expenditure in terms of additional payments to either pro-environmental outcomes (i.e. payments to environmental charities or carbon offset vouchers) or participants (i.e. when choices in the tasks are made by participants for their own personal gain instead of the environmental ones). In some cases, these experiments can be conducted online which is beneficial in terms of collecting data more quickly and at lower costs, but still have the additional financial costs mentioned above associated with them. Also, the majority of these protocols measure indirect pro-environmental behaviors (such as donating money to environmental charities or practices) rather than behaviors (such as individuals reducing their own energy consumption) that can directly impact on the environment (Kollmuss & Agyeman, 2002). There is merit in investigating both types, however in the above list only the PEBT measures direct pro-environmental behavior, but still suffers with the limitations of being costly to use and unable to run online.

In response to the lack of a performance-based measure of direct pro-environmental behavior that is both low in cost and time-efficient, this paper introduces the Email Conservation Task (ECT). This task is conducted online and is based on the potential for email usage to contribute to our individual carbon footprints. In the ECT, participants make a series of choices which vary in terms of the personal and environmental costs, similar to the PEBT and WEPT. Here the personal cost is time spent on a monotonous task (again similar to the PEBT and WEPT) and the environmental cost being receiving unnecessary emails that lead to CO_2 emissions. More specifically participants will be asked, across several trials, to choose (for each trial) between two options; they can either complete a time-consuming task or they can receive an unnecessary email, with the number of the former choices being a positive indicator of pro-environmental behavior (hereafter called the 'ECT score'). By doing so, the ECT measures direct pro-environmental behavior (sustainable email usage) and is very efficient and low in costs to run (online, no additional payments for participants or environmental endeavours) and therefore does not suffer from any of the limitations of the previously mentioned experimental protocols. Such a task therefore can be used more widely and inclusively by the research community to further our understanding of pro-environmental behavior. For example, a recent project[1] aims to increase the proportion of undergraduate research projects in the UK that are conducted on climate change, and a simple and cheap measure of pro-environmental behavior that students can use such as the ECT will be of great value to enable this project to be successful.

For performance in the ECT to be a valid indicator of pro-environmental behavior, it will need to be sensitive to changes in the costs and benefits associated with behaving in a pro-environmental manner or not. Lange et al., (2018) demonstrated this in the PEBT, where decreased amount of time required to complete the task (lower personal cost) and increased carbon emissions from the LED lights (higher environmental cost) led to higher amounts of pro-environmental behavior in the task. Indeed, Lange and Dewitte, (2021) did the same with the WEPT, where decreased amount of monotonous tasks (lower personal cost) and increased donations to charity (higher environmental costs) led to higher scores in the WEPT. Furthermore, in both cases it was found that the scores on the tasks positively correlated with existing self-report measures of pro-environmental behavior.

Therefore, in a similar vein to Lange et al., (2018) and Lange & Dewitte, (2021), this pre-registered study will examine if varying the personal costs of behaving in a pro-environmental way (the amount of monotonous tasks to complete) as well as the environmental costs (the size of email sent, and therefore its

[1] The 1 in 5 Project, see www.1in5project.info for further details.

related carbon emissions) affects levels of pro-environmental behavior in the ECT. To vary the size of environmental cost, emails will be sent either with or without attachments, as the former leads to an increased environmental cost (e.g. Berners-Lee, 2020). Additionally, this study will also examine if ECT scores positively correlate with other established measures of pro-environmentalism, more specifically environmental attitudes (Milfont & Duckitt, 2010), self-reported pro-environmental behavior (Markle, 2013) and environmental concern (Dunlap et al., 2000).

Subsequently, this study tests the following pre-registered hypotheses;

Hypothesis 1: Participants will score significantly higher on the ECT when personal costs (in terms of number of tasks per trial) are lower.

Hypothesis 2: Participants will score significantly higher on the ECT when the environmental costs associated with trials are higher (i.e. higher carbon emissions from emails with attachments vs those without attachments).

Hypothesis 3: Scores on the ECT will positively correlate with scores on the Environmental Attitudes Inventory (Milfont & Duckitt, 2010), the Pro-Environmental Behavior Scale (Markle, 2013) and the New Ecological Paradigm Scale (Dunlap et al., 2000).

Details of the study pre-registration can be found at the following Open Science Framework link https://osf.io/9jzxg/?view_only=5e45eecac22d45169fda18317a11bb43. This includes hypotheses, confirmatory statistical analyses to test these hypotheses, details of the study methods, and sample size calculations.

2. Materials and Methods

2.1. Participants

A pre-registered power analysis was conducted using G*Power (Faul et al., 2009) to determine required sample size. To ensure that all analyses for the above hypothesis were adequately powered, the power analysis was based on the correlational nature of Hypothesis 3 which is the least powerful, similarly to Lange et al., (2018). Again, similar to Lange et al., (2018), to detect a medium effect size (r = .3) with 95% power (two-tailed) and with a corrected alpha level of 0.017 (i.e. 0.05/3 which is the number of correlations conducted) requires 153 participants. This is based on the assumption the data collected will be parametric in nature, however if not and Spearman correlations are more appropriate then this will need to be accounted for in the sample size calculation. As the latter are only 91% reliable compared to the former, we increased the required

sample size by 153/.91 (as Lange and Dewitte [2021] also did), which equates to a final sample of 168 participants required.

In total, 175 participants (mean age = 40.2 years, *SD* = 13.3) were recruited, of which 103 identified their gender as female, 70 identified as male, 1 preferred not to say and 1 identified as other. All participants were recruited via Prolific, and payment was at a 'good' rate for 25 minutes which was the approximate maximum possible duration of the study. All participants were based in the UK, otherwise the standard sample function in Prolific was used, which distributed the study to all available participants. No specific exclusion criteria were applied (in line with the pre-registration) and no covariates were used in any analyses or further measures collected than those outlined in this paper. This study was approved by the institutional ethics committee of the university of the corresponding author.

2.2. Materials

2.2.1. Pro-Environmental Behavior Scale (PEBS) (Markle, 2013). This is a 19-item scale to assess participants' self-reported environmental behavior across a number of dimensions including conservation (e.g. "How often do you turn off the lights when leaving a room?"), citizenship (e.g. "How often do you talk to others about their environmental behavior?"), food use (e.g. "During the last year have you decreased the amount of beef you consume?") and transportation (e.g. "During the past year how often have you used public transportation?"). Response scales varied according to the item, including asking participants the frequency with which they engage in certain behaviors (for example, "How often do you turn off the TV when leaving a room?" was rated on a 5-point Likert scale), or asking for yes/no responses (for example, "Are you currently a member of any environmental, conservation, or wildlife protection group?") or asking for more specific information (for example, participants responded to the item "At which temperature do you wash most of your clothes?" with either 'hot', 'warm' or 'cold'). Please see Markle, (2013) for full details of the scoring of the PEBS. For this study the participants' overall PEBS scores were used, which had a Cronbach's Alpha of 0.8 (Markle, 2013) and 0.7 in the present study.

2.2.2. The Environmental Attitudes Inventory-24 (EAI-24) (Milfont & Duckitt, 2010). This measures environmental attitudes across twelve subscales such as enjoyment of nature (e.g. "I really like going on trips into the countryside, for example to forests or fields"), environmental threat (e.g. "Humans are severely abusing the environment") and ecocentric concern (e.g. "It makes me sad to see forests cleared for agriculture"), and there were two questions in the EAI-24 for each subscale. Participants rated their agreement with each item

on a 9-point Likert scale. For the purpose of this study participants' overall scores for the EAI-24 were used as with Lange et al. (2018), which has a reported Cronbach's alpha of 0.87 in the original study (Milfont & Duckitt, 2010) and 0.67 in the present study.

2.2.3. The New Ecological Paradigm Scale (NEPS) (Dunlap et al., 2000). This 15-item scale assesses the respondent's "pro-ecological" world perspective. Participants rated their agreement with various statements such as "The balance of nature is very delicate and easily upset" and "Humans are seriously abusing the environment" on a 5-point Likert scale. Participants' overall scores on the NEPS were used here, which reported a Cronbach's alpha of 0.81 in the original study (Dunlap et al., 2000) and 0.86 in the present study.

2.2.4. The Email Conservation Task (ECT). This task was created using JsPsych (de Leeuw, 2015) and hosted online on local servers. In each trial in this task, participants are presented with a choice; they can choose to receive an email or not. If they choose to receive an email, they will be sent an email automatically to an email address of their choosing (participants are requested to enter a personal email address to which they would be happy to receive emails during the duration of the study) and then progress immediately to the next trial. If they choose to not receive an email, participants are then required to complete a number of trivial and boring number discrimination tasks (odd/even). Once they had completed the required number of these tasks, they then progress to the next trial. As mentioned in the introduction, an individual's ECT score is the total number of times they chose the 'no email' option. This is because it is a direct measure of pro-environmental behavior, due to the reduced environmental costs associated with conserving the number of unnecessary emails that were sent. In the present study, participants faced twelve trials and the amount of number discrimination tasks participants needed to complete for each trial in the 'no email' option varied (either 8, 16 or 24). Also, participants were randomly allocated to one of two versions of the study, where participants were informed that each email they received would also contain an attachment ($N = 91$) or would not ($N = 84$). As estimates suggests the CO_2 emissions are considerably higher for emails with attachments than those without, this creates the variation in environmental costs between these conditions.

2.3. Procedure

After the information sheet and providing informed consent, participants were asked to provide demographic information (gender, age). Following this, they completed the self-report measures of the PEBS, EAI-24 and NEPS in that order.

On the next page, participants were introduced to the ECT. It was explained to them that they will face several different trials that need completing, and that for each trial they have two options about how to complete it. They are told that if they choose the '*email*' option, an email will be sent to their email account[2], and they will then skip immediately to the next trial without needing to do anything else. Conversely, if they choose the '*no email*' option they are told this will take longer, as they will need to complete several repetitive tasks (discriminating between odd and even numbers on the screen) before going to the next trial. Furthermore, participants are informed that at the start of each trial, they will be told how many individual number discrimination tasks will need to be completed for the 'no email' option in that trial, before choosing their option for that trial. Finally on this page, participants are asked to provide a valid email if/when they choose the 'email' option and were informed that they can check to see these emails arrive in their inbox over the duration of the study. This final piece of information was included to ensure participants were aware that environmental costs in the ECT were indeed real rather than hypothetical, as these emails were in fact delivered in real time to participants whilst they completed the study.

The next page informed participants of the environmental costs of using emails, and they were asked to read these details before answering questions about this content on subsequent pages. Following a brief introduction to general email use, participants were asked to consider how sending emails can be damaging for the environment. They were informed that each email sent and received leads to carbon emissions that can contribute to climate change, and that a regular email is estimated to have a carbon footprint of up to 4g of CO_2 (participants are also provided with a link to a recent news article[3] which provides evidence of this estimate and external validation of the message of this page). Participants were subsequently presented with estimates of the yearly CO_2 emissions from sending and receiving emails, and finally asked to consider in the future reducing their unnecessary email use to help in the fight against climate change. See figure 1 for an example of this page from the ECT.

[2] Participants had been informed at the start of the study that although the study may require their email address, it was optional and only used in the duration of the study and not stored as part of the data collection.
[3] https://www.bbc.com/future/article/20200305-why-your-internet-habits-are-not-as-clean-as-you-think

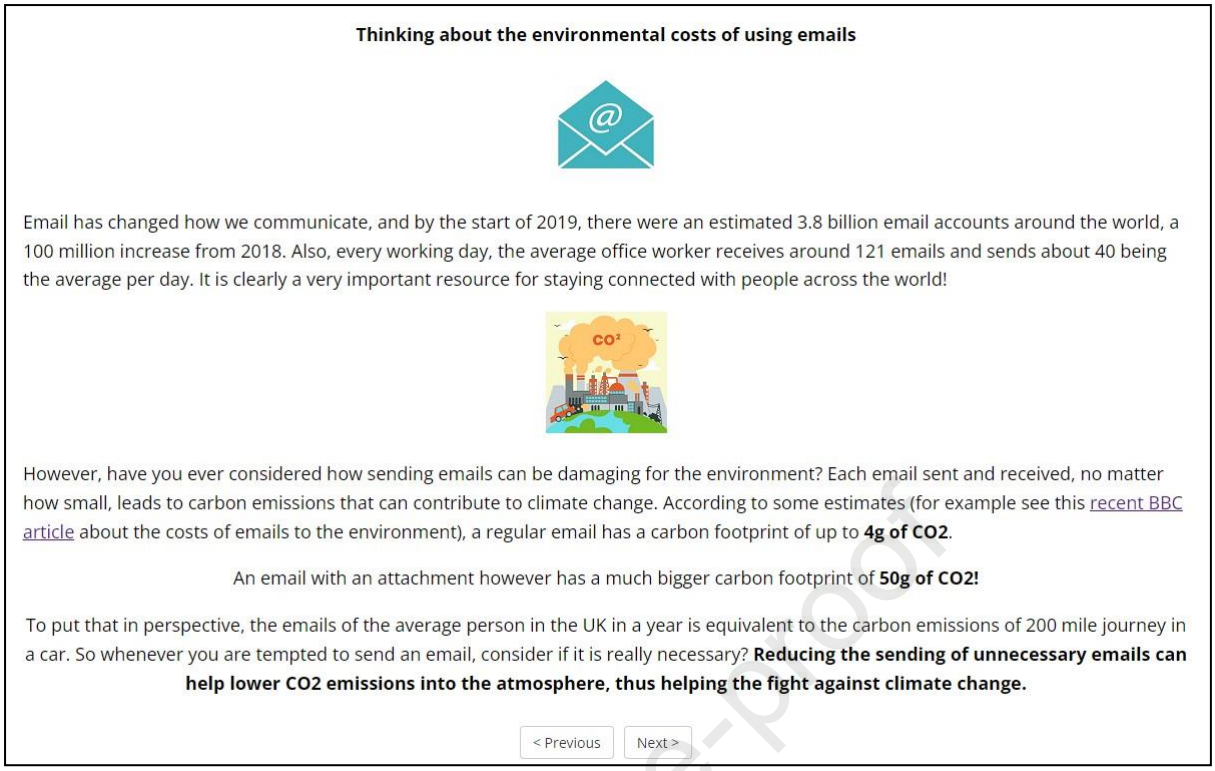

Figure 1. Example of the page in the ECT where participants are informed of the environmental costs of unnecessary emails.

Participants were then asked three true/false questions on the following pages that reiterated the key information about the environmental costs of email use (the cost of individual emails, yearly average CO_2 emissions from emails, reducing email use to tackle climate change). If participants chose the incorrect option, there would be a brief reminder of the correct information provided on the screen. Following this, participants were presented with a reminder of the task, as well as final instructions about how to enter their choices for each trial.

This then led to the beginning of the task, and the presentation of the trials. As mentioned in section 2.2.4, at the start of each trial, participants were informed how many number discrimination tasks they would need to complete if they chose the 'no email' option. They were also reminded that if they chose 'email' then this would lead to unnecessary CO_2 emissions. For each trial, if participants chose 'email' they were required to enter and submit their email address, then to click the 'email' button at the bottom of the screen to go immediately to the next trial. This led to an automatic email being sent to this address. The content of this email informed participants that this email had been sent as they had chosen the 'email' option on that trial, and that this had led to an amount of CO_2 being emitted. Furthermore, they were reminded that if they had not completed

the study (i.e. they had opened and read this email as it arrived in their inbox during the study), that they needed to return to complete any remaining trials.

If they chose the 'no email' option they were presented with instructions for the number discrimination task (press the 'O' key if the number on the screen was odd, and the 'E' key if the number was even). After pressing any button, the task began with a randomly selected number between one and ten being presented on the screen, and after the participant pressed either the 'O' or 'E' key there was a 1.5 second delay before the next number was presented. This continued for the allotted number of iterations for that trial (either 8, 16 or 24 iterations), before proceeding directly to the next trial. See figure 2 below for an example of a trial that was presented to participants. Overall participants completed twelve trials, four of each of the three amounts of number discrimination tasks needed (8, 16, and 24), the order of which was randomly allocated. Once all trials had been completed, this was the end of the study. Further examples of the study materials as viewed by participants are included in the OSF link included in section 1 above.

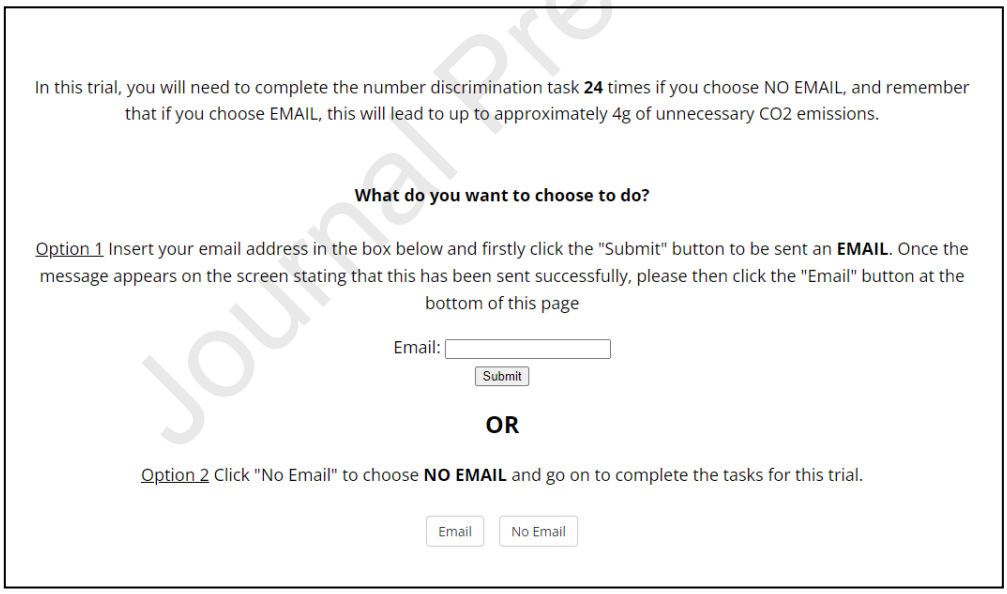

Figure 2. Example of a trial in the ECT, where the amount of number discrimination tasks will need to be completed (in this example, 24) and reminders of the approximate CO_2 emissions if the 'email' option is selected.

As mentioned previously, participants were randomly allocated to a condition where the task involved sending emails with attachments, or a condition where emails without attachments were sent. This was included as a between-subjects variable in the study design as opposed to an additional within-subjects variable (as was

the case with number of tasks per trial) to manage the overall length of the study for participants. This precautionary measure was firstly due to the need to reduce any possible floor effects in the ECT data collection (i.e. participants choosing the 'email' option too often to complete the study due to it being overly long) which would prevent appropriate testing of the hypotheses to be conducted. Secondly, it was due to the typical higher dropout rate of participants observed in online research (Reips, 2021) which would have a further potential detrimental effect on the conclusions that could be drawn for this initial assessment of the ECT (Zhou & Fishbach, 2016). To differentiate the 'with attachment' and 'without attachment' conditions in the procedure, participants were informed of this in the initial instructions (they were told they would receive either an email or an email with an attachment), and details about the additional costs of sending emails with attachments was included on the environmental costs of using emails page (after being informed a regular email led to up to approximately 4g of CO_2 being emitted, participants in the attachment condition were then informed that an email with an attachment led to up to 50g of CO_2 being emitted[4]). Furthermore, the details of the approximate amount of CO_2 emissions that the 'email' option would lead to on each trial varied between the two conditions (4g in the 'without attachment' condition and 50g in the 'with attachment condition'). Finally, the emails received by participants who chose 'email' options varied, in terms of having an attachment (which was a PNG file of a university logo) or not in the respective conditions, and reminders of the different approximate amounts of unnecessary CO_2 emissions in the body of the email text (50g/4g).

3. Results

All analyses presented below have been pre-registered, and data and analysis can be accessed in the OSF link included in section 1 above. To test hypotheses 1 and 2, a repeated measures ANOVA was conducted with number of tasks per trial (8, 16, 24) as a within-subjects factor and type of email (with attachment, without attachment) as a between-subjects factor. As the assumption of sphericity was violated, Greenhouse-Geisser corrected results were used and, where relevant, Holm corrections were applied to post-hoc pairwise comparisons. To test hypothesis 3, Pearson correlations were conducted between participants' overall ECT scores and scores on the NEPS, EAI24 and PEB. To control for multiple tests for hypothesis 3, a sequential Bonferroni adjustment was used to calculate an initial alpha level of 0.017 by dividing the standard alpha level (0.05) by the number of tests (3) for the largest correlation.

[4] Again, this difference was clearly evidenced in the BBC news article that was available to participants.

Descriptive statistics for ECT scores across all conditions are presented below in Table 1. Further details of the frequency distribution of scores on the ECT across the different amounts of tasks per trial and in total, as well as histograms representing these, are provided in the Supplementary Materials. Furthermore, exploratory (non-preregistered) analyses were also conducted which examined the role of the demographic characteristics of participant age and gender on performance on the ECT, as well as that of participants' responses to the manipulation check questions that followed presentation of information the environmental costs of using emails (see section 2.2.2). These are also included in the Supplementary Materials, and it was found that neither participant age, number of correct manipulation check question or gender had a significant effect on ECT scores.

Table 1

Mean ECT scores (including S.D. and ± 95% C.I.) across all number of tasks versions (8, 16, 24) and totals for both the with and without attachment conditions.

				95% Confidence Interval	
Number of tasks	**Email Type**	**Mean**	**SD**	**Lower**	**Upper**
8	Without Attachment	2.80	1.56	2.46	3.13
	With Attachment	3.16	1.36	2.89	3.44
16	Without Attachment	2.37	1.73	2.00	2.74
	With Attachment	2.80	1.56	2.48	3.12
24	Without Attachment	2.21	1.74	1.84	2.59
	With Attachment	2.88	1.46	2.58	3.18
Total ECT score	**Without Attachment**	**7.38**	**4.71**	**6.37**	**8.39**
	With Attachment	**8.85**	**4.07**	**8.01**	**9.68**

3.1. Hypothesis 1

There was a significant main effect of the number of tasks per trial ($F_{[2,346]} = 20.88$, $p < 0.001$, $\eta_p^2 = 0.11$). Subsequent pairwise comparisons revealed that participants chose the 'no email' option significantly more often when there were only eight tasks to complete than when there were 16 tasks ($P_{Holm} < 0.001$, $d = 0.4$, 95% CI [0.22, 0.58]) and when there were 24 tasks ($P_{Holm} < 0.001$, $d = 0.44$, 95% CI [0.26, 0.61]) per trial. There was no difference in the number of choices of no email options between 18 tasks and 24 tasks per trial ($P_{Holm} = 0.56$, $d =$

0.04, 95% CI [-0.14, 0.22]). Furthermore, there was no significant interaction between number of tasks per trial and type of email ($F_{[2,346]} = 2.21$, $p = 0.11$, $\eta_p^2 = 0.01$). See figure 3 below.

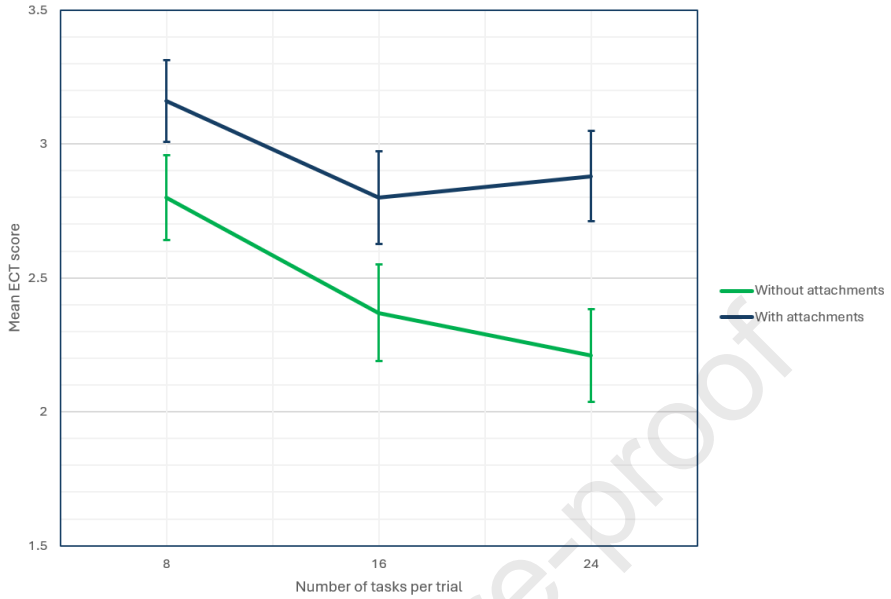

Figure 3. Visual representation of mean ECT scores (± S.E.) across the different amounts of tasks per trial for both with and without attachments conditions.

3.2. Hypothesis 2

There was a significant main effect of type of email on overall ECT scores ($F_{[1,173]} = 4.87$, $p = 0.029$, $\eta_p^2 = 0.027$), with participants scoring higher when the emails sent had an attachment. As mentioned in 3.1, there was no further significant interaction with number of tasks per trial. See figure two.

3.3. Hypothesis 3

There were significant positive correlations between total ECT scores and PEBS ($r = 0.24$, $p = 0.001$, 95% CI [0.1, 0.38]), the EAI-24 ($r = 0.26$, $p < 0.001$, 95% CI [0.11, 0.39]), and the NEPS ($r = 0.18$, $p = 0.019$, 95% CI [0.03, 0.32]). Note that the correlation between ECT and NEPS is significant in comparison to an alpha level of 0.05, which, as it is the smallest of the three correlations calculated, is in line with the sequential Bonferroni adjustment procedure. Furthermore, assumption checking prior to analysis indicated that the scores were not normally distributed, however non-parametric calculations of these correlations (Spearman) had no

effect on the significance of the findings highlighted here (details of the assumption checks and the alternative Spearman corelation results can be found in the Supplementary Materials).

4. Discussion

Overall, all hypotheses were supported from the results of this study. It was found that participants scored significantly higher on the ECT when the personal cost was low (hypothesis 1) as the pro-environmental option of 'no email' was chosen significantly more when there were only eight number discrimination tasks to complete in a trial as opposed to when there were either 16 or 24 to complete. Interestingly, there was no such difference between 16 and 24 tasks, suggesting the effect of personal cost was less important once the number of tasks needed to complete a trial passed a certain threshold. This is something that future research can investigate in terms of the role of personal costs in affecting ECT scores. Furthermore, participants scored significantly higher when the environmental benefit of doing so was greater (reducing the number of emails with attachments being sent, with their greater approximate CO_2 emissions) than when it was less (reducing the number of emails being sent without attachments), supporting hypothesis 2. Finally, ECT scores were significantly and positively correlated with existing self-reported measures of different dimensions of pro-environmentalism (NEPS, EAI-24, PEBS), providing full support for hypothesis 3.

Therefore, the results shown here provide clear evidence of the validity of the ECT as a direct measure of actual pro-environmental behavior. As such, it is anticipated that the ECT can be a valuable addition to the existing canon of experimental measures of pro-environmental behaviour, which answers the call within the literature for more of such measures in environmental research. Furthermore by virtue of utilising the novel domain of sustainable email usage, the ECT can allow researchers in future to understand a broader range of pro-environmental behaviors (Lange, 2022; Lange et al., 2023; Lange & Dewitte, 2019). As part of this, it will be of value to explore how performance on the ECT relates to performance on other behavioral measures (Deltomme et al., 2023).

These findings can also contribute to recent considerations of the strength of associations between behavioral and self-report measures of pro-environmental behavior (Delcourt et al., 2024). As such, the strength of relationships observed in relation to hypothesis 3 can be viewed as consistent with those reported for other behavioral measures and various self-report measures of pro-environmental behavior (Berger & Wyss, 2021; Essl et al., 2023; Krebs et al., 2023; Lange et al., 2018; Lange & Dewitte, 2021). However, although the NEPS

and the EAI-24 have previously been found to correlate to other behavioral measures (e.g. PEBT, WEPT, the Tree Task), the PEBS has not been similarly used. Although in such cases caution may be needed when interpreting the use of a measure in a novel setting as a result, the PEBS has been used successfully in other research exploring environmental behavior in different domains (e.g. Colombo et al., 2023; Diessner et al., 2018; Dunne et al., 2024; Innocenti et al., 2023) and as mentioned above the size of relationship between the ECT and the PEBS is commensurate with the other self-report measures used here and that of other behavioral measures and self-reported measures of environmental behavior.

The further values of the validated ECT are three-fold; firstly it is relatively easy and efficient to use in research (it is online), secondly it is cheaper than existing measures of pro-environmental behavior (it relies on time rather than money as the currency of pro-environmentalism) and thirdly it measures direct (actual energy conservation via email use), rather than indirect, pro-environmental behavior (Kollmuss & Agyeman, 2002) which the aforementioned existing measures all use (bar the WEPT). The ECT therefore is the only measure of pro-environmental behavior that has all these benefits, and by providing strong evidence of its validity here this offers a promising path to its use in future research. However despite these advantages, it is important to note that a potential disadvantage with the ECT in its current form is that it is relatively inflexible in the dependent variable it measures (CO_2 emissions from email use), whereas other behavioral measures can be adapted. For example, different environmental charities can be used, and the PEBT has been assessed with different symbolic contexts (e.g. car versus bike and more arbitrary labels) (Lange et al., 2018). Consequently, Lange and Dewitte (2021) found that framing the PEBT as a car versus bicycle option led to it having a strong correlation with conservation of gasoline, which shows the value of adaptability in such measures which the ECT currently lacks. Overall, the ECT can however make a significant contribution and provide a broad and inclusive opportunity for all researchers to be able to measure pro-environmental behaviour in a valid manner. This can also further facilitate large studies across different populations which are offering increased value to our understanding of environmental behavior (e.g. Vlasceanu et al., 2024).

Of particular salience in the current study is the use of a relatively unfamiliar environmental issue, that of email usage. Whereas other pro-environmental behavior measures use well-known and normative concerns (e.g. light energy usage, environmental conservation charities, tree planting), this was not the case with reduced email use in the ECT. Indeed, anecdotal discussions with the public will highlight how few are aware that this is an environmental issue, and furthermore it can be argued that reducing email use is not an intuitive environmental concern in the same way as, for example, tree planting is. As a result of this, there was a need for

the current study to both inform participants of the environmental costs of email use, and furthermore to convince them that this is indeed a real cost. This led to this message being promoted quite explicitly in the design (such as continuous reminders of CO_2 emissions, and the inclusion of a link to an external news article) – something that arguably would not be necessary for other environmental behaviors. It is worth noting the further strength of the ECT in relation to this, as it has shown that even without strong cultural social norms around this particular behavior, it has still been shown to be highly applicable to an experimental measure of pro-environmentalism. Additionally, this lack of social norms may also have contributed to the unusual findings of no effect on ECT scores of an individual's age and gender on environmental behavior. This has been evidenced previously in relation to different attitudes and perceptions as well as different facets of environmentalism (Ágoston et al., 2024; Berger & Wyss, 2021; Geiger et al., 2019; Swim et al., 2020). It is possible that without such norms, the influences of age and gender are greatly reduced in the ECT, something that future research can explore (as well as investigating the effects of other demographic characteristics such as income and education).

A potential limitation of the current findings may lie in the relatively low environmental costs associated with unnecessary email use. This is counter to a growing desire in environmental psychological research to concentrate on areas which will have a higher impact in the fight against climate change (Bosshard et al., 2024; Nielsen et al., 2021, 2024). However it is important to recognize that the key aim of the ECT is to contribute significantly to the existing collection of measures of pro-environmentalism (rather than concentrating just on email usage *per se*), and by doing so answers the call for more diversity and areas in which pro-environmental behavior are measured (Nielsen et al., 2024). Irrespective of the low impact to the environment of email usage, there remains clear evidence from the support of the three hypotheses here that, regardless of the actual costs, individuals completing the ECT were influenced. Furthermore, the costs entailed in terms of CO_2 emissions in the ECT is not dissimilar in magnitude to those of the PEBT (Lange et al., 2018) and also it can be argued that without familiar comparisons, the amount of CO_2 emissions reported for email usage may be difficult to comprehend. This is why the comparisons to familiar environmental costs were included in the wording of the study materials and in the external news article link (equivalence to car travel) which overall suggests that participants were viewing email use as a significant source of environmental costs, and behaved accordingly. When also considering the relatively high frequency with which participants chose 'no email' for all of the twelve trials (which can be seen in the Supplementary Materials), it is possible that participants were willing to incur greater personal costs to avoid unnecessary emails in this study. As a result, it is suggested that future research using the ECT can use this information appropriately, such as being able to use

more trials of the ECT and/or more tasks completed per trial (16 or 24, rather than 8), to measure individual differences in pro-environmental behavior successfully.

A further potential issue is in the lack of clarity and consensus on the CO_2 emissions associated with email use (e.g. Berners-Lee, 2020), which is why it was made explicit to participants that the values included in the ECT were estimates. Future research therefore can explore how variation associated with the environmental costs incurred can be incorporated into the ECT, such as using different estimates of email use and/or providing participants with explicit details of the inconsistency in these estimates (in other words, does a reduced consensus in the costs of email use negatively impact behavior in the ECT?). It can also explore how different environmental costs in the ECT affects behavior, such as larger attachments (higher costs) or smaller spam-type emails (lower costs). Another means of examining the role of environmental costs can be to include more detailed and complete information of total environmental costs incurred in the task. This could include estimates of CO_2 emissions from energy consumption related to merely the additional time incurred using an electrical device in the no email option compared to the costs of email use. Research can also now explore how varying the messaging surrounding email use (for example, using more subtle and indirect messaging or different sources of evidence) may lead to variation in overall ECT scores.

Further potential limitations may lie in the methodology used here. One such issue is in the requirement for participants to input their email address if the 'email' option was selected, as due to the ethical consideration of participants' anonymity, this was unrecorded. As a result, it is unknown if incorrect or false emails were used here by some participants. However it is anticipated that this would only be a relatively minor occurrence, and even if it did occur, participants would still be aware that the email would be sent, and the associated CO_2 emitted as a result. Furthermore the participant would not personally benefit anyway (they would not save any further time). It would therefore have little to no effect on participants' decision-making processes that is required for the validity of the ECT (incurring personal or environmental costs), however possible mitigations of this can be explored in future developments of the task. Another consideration was measuring the environmental costs (with/without attachment) as a between-subjects variable, which as well as resulting in a reduction in statistical power was also contrary to the designs of similar measures (e.g. Berger & Wyss, 2021; Lange & Dewitte, 2021). As mentioned above, this was included as a precautionary measure to reduce potential dropout rates and floor effects, and it is important to note that the sample obtained means that the study overall was suitably powered. It is suggested though that future research can include this environmental cost as a within-subjects measure, which would further model the normal consequential decisions we make every day in terms of

pro-environmental behavior. Further studies can also expand on the current methodology, such as by looking beyond the UK only to sample participants and varying the order of materials (for example, having participants complete the ECT before completing self-report measures of pro-environmentalism). Such replications will both further assess the validity of the ECT, and also answer the necessary call for increased reproducibility in psychological research.

In conclusion, the results presented here offer strong support for the use of the ECT in future attempts to understand and facilitate environmental behavior. For example, it can be seen how various interventions and manipulations can affect individuals' behavior in simple and controlled ways, offering the first stage of testing that may eventually lead to the development of real-world applications and policies. It is also hoped now that the inclusive and easily accessible nature of the ECT as it develops will encourage its use across a range of research areas, and to reach those areas and researchers for whom access to resources is often limited (for example, undergraduate research students). By doing so, it can open up more avenues of investigation which can ultimately aid our holistic understanding of pro-environmental behavior.

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- Email Conservation Task (ECT) introduced to measure online environmental behavior
- ECT is a low cost, easy to use measure of direct pro-environmental behavior
- Increased environmental and decreased personal costs lead to increased ECT scores
- ECT scores positively correlate with self-report measures of pro-environmentalism
- Strong support for the validity of the ECT in future environmental research
- Due to low costs and ease, ECT can be used in more diverse and inclusive areas