The Role of Eco-Guilt on Pro-Environmental Behaviour and the Moderating Effect of Education in German and Dutch Populations - A Cross-Sectional Study

Abstract

Background: Climate change presents a complex challenge, that calls for individual and collective action. Emotional responses to climate change, such as eco-guilt, not only impact individuals' mental well-being but can also motivate adopting eco-friendly behaviours. To understand the factors that influence individuals to engage in pro-environmental behaviour when experiencing eco-guilt, the present research investigates the impact of educational attainment on this relationship, focusing on the German and Dutch populations.

Methods: Through a cross-sectional online study, the Eco-Guilt Questionnaire (EGuiQ-11) and the Pro-Environmental Behaviour Scale (PEBS) were employed to measure eco-guilt and pro-environmental behaviour, respectively.

Results: Based on data from 232 participants, the analysis reveals a significant positive correlation between eco-guilt and pro-environmental behaviour ($r = .326$, $p < .001$), indicating that higher levels of eco-guilt are associated with greater engagement in pro-environmental behaviour. Furthermore, a moderation analysis showed that educational attainment did not significantly moderate the relationship between eco-guilt and pro-environmental behaviour (all p-values > .05).

Conclusion: This study found that eco-guilt correlates positively with pro-environmental behaviour. While educational attainment did not influence this relationship, further research is needed to confirm the findings and explore additional factors contributing to eco-guilt variations and its impact on pro-environmental behaviour.

Table of Content

Introduction

Climate change is a critical and urgent concern in today's world, affecting ecosystems, societies, and individual well-being on a large scale. Although it is not a new issue, it remains one of the most serious environmental concerns for the global population (Rahman, 2013). The United Nations define Climate Change as "long-term shifts in temperatures and weather patterns" (n.d.). Across different regions, this includes more extreme weather events and rainfall in some areas, and more frequent heatwaves and lengthy droughts in others (Rummukainen, 2012). Anthropogenic activities, such as industrialisation, deforestation, and reliance on fossil fuels have significantly impacted the Earth's climate, which resulted in a spiral of environmental changes (Intergovernmental Panel on Climate Change [IPCC], 2018). This contemporary crisis, which started to gain attention in the 1970s, raised widespread public concerns about the effects of human activities on ecological systems. The recognition of climate change as a major issue has resulted in several beneficial outcomes, including increased climate advocacy, public knowledge and pro-environmental behaviour and actions (Minelgaitė & Liobikienė, 2021). However, in addition to these positive advancements, climate change itself, as well as the awareness and concern about its consequences, have a negative impact on mental health.

Health Consequences of Climate Change

Climate change affects physical and mental health in both, direct and indirect ways (Berry et al., 2009). It not only increases the risk to physical health through factors like the spread of disease-carrying insects or the destruction of infrastructure and healthcare systems caused by extreme weather events but also impacts mental well-being (World Health Organization, 2023; IPCC, 2014).

Traumatic events like floods can lead to long-term mental health issues such as anxiety (Dai et al., 2017), post-traumatic stress disorder (PTSD) (Goldmann & Galea, 2014), depression (Cruz et al., 2020) and increased aggression, especially among children (Olness,

2022). Furthermore, the destruction of landscapes that frequently follow catastrophic weather events can disrupt individuals' sense of belonging and comfort, while displacement can lead to feelings of loss, uncertainty and social isolation, further increasing mental health issues (Higginbotham et al., 2006; Osofsky et al.,2011).

In Germany and the Netherlands, the impacts of climate change on mental health are particularly relevant due to their vulnerability to sea-level rise and extreme weather. According to a survey by vivida bkk (2023), over three-quarters of young Germans (aged 14 to 34) experience psychological distress from climate change. In the Netherlands, the constant threat of flooding causes anxiety and fear among residents (Baan & Klijn, 2004).

As climate change continues to impact ecosystems and societies, there is a growing interest in how individuals experience and cope with emotional responses related to environmental changes. Research into eco-emotions like eco-guilt, which reflects individuals' feelings of guilt and responsibility for their environmental actions is becoming more prevalent.

Eco-Guilt: An Emotional Response to Environmental Impact

Direct and indirect impacts of climate change contribute to the emergence of what has been called *eco-emotions*. These emotions are understood as emotional responses to environmental crises and are connected with psychological well-being (Pihkala, 2022). Eco-guilt is the emotional response individuals feel when they believe they have violated personal or societal norms regarding environmental behaviour (Mallett et al., 2013). It involves feelings of personal responsibility, self-criticism, introspection, self-blame and discontent with one's environmental decisions (Ágoston et al., 2022a). Unlike eco-anxiety, which involves ongoing concern for the environment's future, and eco-grief, which is grief over the loss of the ecosystem, eco-guilt focuses specifically on one's environmental behaviours and actions (Ágoston et al., 2022a; Cunsolo & Ellis, 2018).

Feelings of eco-guilt can arise both, individually, through for example consumption habits or lifestyle choices, and collectively, as individuals identify with groups they perceive as not sufficiently addressing climate-related issues (Fredericks, 2021; Pihkala, 2022). Although the experience of this emotion can result in long-term feelings of complex guilt, it also plays a crucial role in influencing and adjusting pro-environmental behaviour. According to the Environmental distress-response model of Higginbotham et al. (2006), responses to climate change start with direct and indirect experiences of environmental changes. These experiences lead to evaluations of perceived threats and considerations of coping mechanisms, while emotional reactions, including feelings of eco-guilt play an important role in this process. Eco-guilt can enhance the perceived threat of environmental changes, motivating individuals to engage in problem-solving and self-protection methods. Ultimately, this can influence whether individuals take action to combat climate change.

Pro-Environmental Behaviour and Eco-Guilt

Pro-environmental behaviour and actions refer to actions and behaviours by individuals or groups that reduce harm to the environment and help protect it (Steg & Vlek, 2009). At an individual level, individuals can make proactive adjustments through daily routines and actions, such as changes in transportation habits or consumption choices, e.g., using public transportation, recycling, and avoiding single-use products. These actions help reduce the waste of natural resources and enhance environmental sustainability, therefore providing effective solutions to environmental issues (Tian & Liu, 2022).

Negative emotions like eco-guilt are commonly experienced in reaction to climate change, but according to Iniguez-Gallardo et al. (2021) they can be considered as constructive reactions that can drive pro-environmental behaviour.

Guilt encourages self-reflection, which can lead to adaptive and pro-social behaviours (Tracy & Robins, 2007). This in turn can motivate individuals for instance to strive toward goal achievement, repair wrongdoing and engage in behaviours that are socially valued (Hurst

& Sintov, 2022). Research by Harth et al., (2013), highlights in their research, that although eco-guilt is strongly associated with specific environmental actions aimed at repairing damage, it does not effectively motivate broader pro-environmental tendencies.

Arousing guilt can in some cases cause the opposite effect and lead to avoidance and withdrawal behaviour, especially when individuals feel personally criticised (Ágoston et al., 2022a; Orth et al., 2006). However, when guilt is framed as an evaluation of a specific behaviour rather than a personal critique, it can motivate reparative actions. Many variables can influence the relationship between eco-guilt and pro-environmental behaviour, for example, individuals' socioeconomic characteristics, among which the level of received education (Callan & Thomas, 2006; Meyer, 2015; Ferrara & Missios, 2005).

Education as a Factor

Extensive research has been conducted into the socioeconomic factors impacting pro-environmental behaviour, with education appearing as a significant predictor in a variety of circumstances (Meyer, 2015). According to the research of Chankrajang and Muttarak (2017), individuals with higher educational attainment tend to show greater concern regarding global warming. Similar, studies, such as those from Callan & Thomas (2006), Ferrara & Missios (2005) and Meyer (2015) show a link between higher educational attainment and environmentally friendly behaviour, such as recycling. Furthermore, educational attainment often influences people's dietary choices, with more educated individuals preferring ecologically friendly food selections (Zepeda & Li, 2007). However, the literature displays a contradictory picture, as not all research consistently shows a positive association between educational attainment and pro-environmental behaviour (Millock & Nauges, 2010; Grafton, 2014). While education can raise awareness of environmental concerns and their consequences, this awareness might not always lead to pro-environmental behaviour (Kollmuss & Agyeman, 2022). The heightened awareness can also cause individuals to feel overwhelmed or helpless when confronted with challenges like climate change (Clayton et al.,

2021). According to Ágoston et al. (2022b) the influence of education on promoting negative emotions related to the ecological crises remains unclear.

Previous Research

As the awareness of the psychological effects of climate change, like eco-guilt grows, there is an increasing interest in studying these emotions not only for their negative impacts but also for their potential to drive positive actions, particularly in promoting pro-environmental behaviours and actions (Moore, 2019).

Previous research has shown that eco-guilt can motivate pro-environmental behaviours (Mallett, 2012), and educational attainment has also been linked to heightened pro-environmental behaviour (Callan & Thomas, 2006; Meyer, 2015). However, the research on both effects remains inconsistent, indicating a need for further investigation.

Additionally, there is a notable gap in studies specifically tailored for the German and Dutch populations that measure eco-guilt. Ágoston et al. (2022b) created a new measurement tool to assess the complex emotions related to climate change. However, these questionnaires were initially implemented only with Hungarian respondents, therefore further research is needed to explore eco-guilt in different cultural contexts.

Current research

The current research aims to build upon previous research regarding emotional responses and their influence on pro-environmental behaviour. As the impact of climate change will become increasingly evident in Germany and the Netherlands, emotional responses to these events will become more prevalent. While there is limited research on which factors might impact this relationship between eco-guilt and pro-environmental behaviour, this research tries to fill this gap by focusing on the moderating effect of education. Thus, this study aims to investigate the following research question: "*To what extent does eco-guilt influence pro-environmental behaviour in the German and Dutch populations and is this relationship moderated by educational attainment?*"

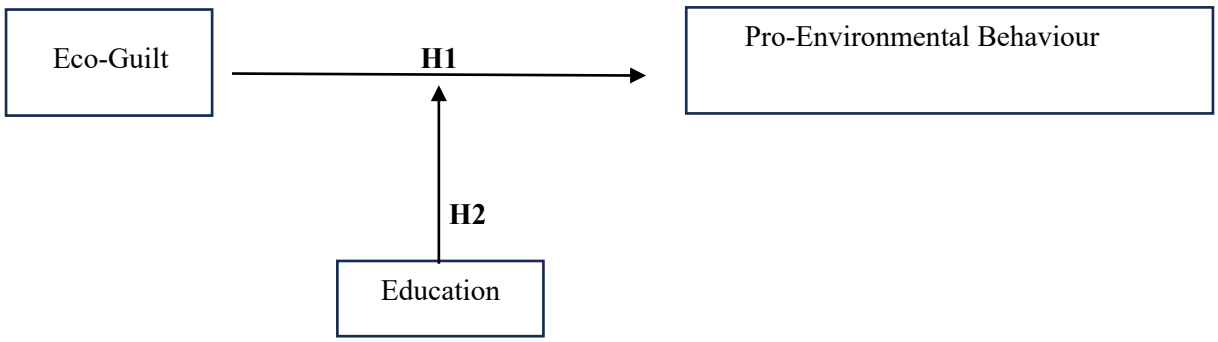
Hypothesis 1 (H1): Individuals with higher levels of eco-guilt exhibit higher levels of pro-environmental behaviour in both, the German and Dutch populations.

Hypothesis 2 (H2): Individuals with higher levels of education exhibit a stronger correlation between eco-guilt and pro-environmental behaviour in both the German and Dutch populations, indicating a positive moderating effect of education on this relationship.

Figure 1 represents a graphic illustration of the Hypotheses.

Figure 1

Representation of the Hypotheses



Methods

Design

This study uses a cross-sectional design, incorporating the *Strengthening the Reporting of Observational Studies in Epidemiology* (STROBE) checklist, as detailed in Appendix A. Data is gathered via an online survey to investigate the level of pro-environmental behaviour among the Dutch and German populations. Specifically, the relationship between the independent variable eco-guilt and its influence on the dependent variable pro-environmental behaviour was measured. Additionally, the study seeks to investigate whether the relationship between eco-guilt and pro-environmental behaviour is moderated by education.

Participants

The current study applied eligibility criteria. Firstly, participants must live in Germany or the Netherlands and speak one of the languages to participate in this research. Furthermore, participants must be at least 18 years old. Lastly, individuals currently in treatment for a mental disorder and/or who experienced suicidal ideation in the past 2 years are not eligible to ensure their mental well-being. In order to calculate the appropriate sample size for the study the tool G*Power was used. Here, the sample size n = 210 was calculated (see Appendix B).

Sampling procedure

Participants were sampled through snowball sampling and convenience sampling. Multiple advertisements were created for the online questionnaire in both German and Dutch (See Appendix C). These advertisements were then posted on various social media platforms to recruit participants. They showed eligibility criteria and a short description of the study with the appeal to participate. Furthermore, they included a link directing participants to either the Dutch or German version of the questionnaire. The researchers distributed the survey through platforms such as WhatsApp, Instagram, Survey Circle, and Reddit forums of cities like Rotterdam, Amsterdam, and Groningen. Furthermore, family and friends were asked to forward the advertisement. Moreover, participants were recruited through the platform SONA, which rewards students at the University of Twente with credits for their participation. The questionnaire remained accessible for six weeks, from March 22nd to May 5th in 2024.

Procedure

The entire data collection was conducted through Qualtrics, a platform for online surveys and data collection. Qualtrics was selected for its user-friendly interface, consistent reliability in handling survey data and its advanced security features. At the beginning of the questionnaire, participants received a written introduction outlining the study procedure, objectives, and the use of their data. Additionally, they were informed about the inclusion and exclusion criteria. Lastly, participants were provided with the contact details of the

researchers, for any questions or remarks regarding their participation or the questionnaire (see Appendix I).

Next, participants were presented with an informed consent sheet emphasising voluntary participation and the right to withdraw from the study at any time without providing a reason and without any consequences (see Appendix J). Further, they were informed that no personal data that could potentially identify the participant, such as their IP address, name, or address, would be collected. Following this information, they were asked for their consent to participate in the study.

After providing consent, participants' demographic data was collected, including age, gender, education level and nationality. Additionally, participants were asked about their proximity to water bodies, flood history and rural or urban residency.

Subsequently, participants were introduced to the newly translated versions of questionnaires measuring emotional experiences related to climate change, namely the Eco-Anxiety Questionnaire (EAQ-22), Eco-Guilt Questionnaire (EGuiQ-11), Eco-Grief Questionnaire (EGriQ-6) and the Pro-Environmental Behaviour Scale (PEBS). Following the eco-questionnaires, they were asked to answer already well-established and validated questionnaires for comparison, namely the Guilt and Shame Questionnaire (GSQ-8), the Generalised Anxiety (GAD-7) and the Kessler Psychological Distress Scale (K-10). The Questionnaire included additional scales related to other variables as part of a broader research group investigation. However, since these variables are not relevant to this study, they will not be discussed further in this paper.

At the end of the questionnaire, participants were asked once more if they wished to continue participating to allow participants to confirm their initial agreement. Participants were also asked if their data could be used for subsequent analysis. They were given the option to provide their email for follow-up surveys after 3 and 6 months. In the follow-up study, the same questionnaires will be applied to them again. Following their participation,

their data was subject to different data analysis processes, aimed at answering the researchers' research questions and hypotheses.

Materials

Eco-Guilt Questionnaire (EGuiQ-11). The Eco-Guilt Questionnaire (EGuiQ-11) created by Ágoston et al. in 2022 is used in this study to examine individuals' level of ecological guilt. This 11-item questionnaire was translated into Dutch and German by Doyle (2024) and Gökoglan (2024) and was implemented in 2024. Participants are requested to express their level of guilt, ranging from "strongly disagree" to "strongly agree", regarding environmental concerns using a 4-point Likert scale. Higher scores indicate a high level of Eco Guilt. The EGuiQ- 11 has a single-factor structure and strong internal consistency, with a Cronbach's alpha coefficient of 0.76.

Pro-Environmental Behaviour Scale (PEBS). The Pro-Environmental Behaviour Scale (PEBS), developed by Markle in 2013, serves as a tool to assess behaviours with significant environmental impact. This study uses the German and Dutch translations by Doyle (2024) and Gökoglan (2024) of Markle's questionnaire. The 19-item scale shows strong internal consistency (Cronbach's alpha =.86) for the overall scale. Participants respond using various Likert scales, ranging from binary choices (e.g., "no" and "yes") to five-point scales (e.g., "never" to "constantly" or "always"). The PEBS have four distinct subscales namely, conservation, environmental citizenship, food, and transportation with satisfactory intercorrelations (alpha = .62 to .74). The behaviours align closely with those identified by environmental scientists as having the most considerable environmental impact, enhancing the scale's validity.

Data analysis

For applying data analysis, the software RStudio (RStudio2023.12.1+402) has been used. The complete R code can be found in Appendix K. First, the dataset was imported in CSV file format and the working directory was set. The second step involved the installation

and loading of the required packages, including “tidyverse”, “dplyr”, “knitr”, “ggplot2”, “psych”, “lavaan” “stats”, “jtools”, “lmtest”, and “interactions”. Subsequently, all missing data has been excluded, for example, participants not finishing the survey or did not provide consent to the second consent. The next step included deleting all data that may identify the participant such as the start and end date, status, IP address, duration in seconds, recorded date, response ID, and preview distribution channel. Additionally, columns displaying NA, for instance, the email address, were excluded.

At first, the raw scores were presented for all key variables. Therefore, variables displayed in character format were converted to numeric values to allow further analysis procedures. For example, the EGuiQ-11 variable 'strongly agree' was assigned a numeric factor of 4, while 'strongly disagree' was assigned a numeric factor of 1. Due to having multiple different subscales, the conversion of the scores for the PEBS differentiated from the other questionnaire. Six items of the PEBS could be answered with two values ('no' and 'yes'), nine items with five values (“never”, “rarely”, “sometimes”, “often”, and “always”) and four items with three values (“never”, “sometimes”, “often” and “hot”, “warm”, “cold”). The numeric scores 1 and 5 were used to adapt the raw scores for the dichotomous values, and numeric scores 1, 3 and 5 for the raw scores of the three value items. Next, the items of the different subscales 'Conservation', 'Environmental citizenship', 'Food', and 'Transportation' were grouped into overarching variables and the corresponding mean scores were calculated.

After preparing the different questionnaires for further analysis, the descriptive statistics were computed. The Mean (M) score and Standard Deviation (SD) were calculated for EGuiQ-11 and PEBS. Furthermore, the correlation between these two scales was analysed. Other demographic data, namely gender, nationality, and education levels were then analysed and evaluated. The resulting new variables and models were then checked for normality, linearity, independence, and homoscedasticity. To meet the normality assumption, data transformations including square root and log transformations were applied. However, these

transformations did not sufficiently normalise the data. Therefore, non-parametric tests were employed for subsequent analyses.

G*Power Analysis

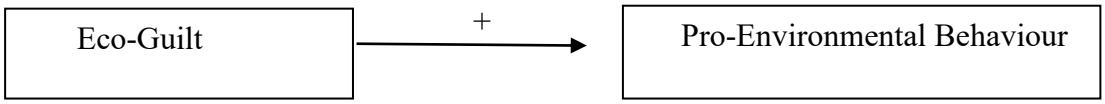
To calculate the appropriate sample size for the current study, the G*Power software was used. Here, an a priori power analysis with two tails and a power level of =.95 was performed. The minimal sample size necessary for a linear regression calculating the difference between two independent means was n = 105 per group, thus a total sample of n = 210 (see Appendix B).

For the following Hypotheses, different analyses were used.

H1: To test the first hypothesis, a correlation analysis was used to test if the independent variable eco-guilt positively correlates with the dependent variable pro-environmental behaviour (see Figure 2).

Figure 2

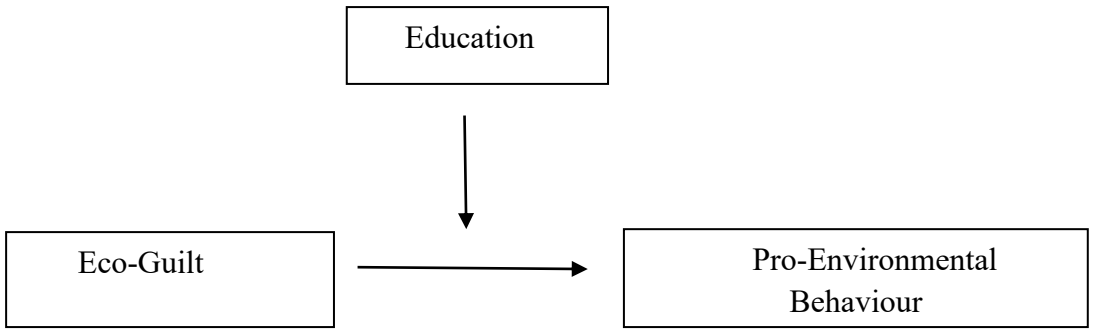
Graph showing the Hypothesised Relation between Eco-Guilt and Pro-Environmental Behaviour



H2: For testing the second hypothesis, a moderated generalized regression analysis was used to examine whether educational attainment moderates the relationship between eco-guilt and pro-environmental behaviour. Therefore, the independent variable is eco-guilt, pro-environmental the dependent variable and educational attainment the moderator (see Figure 3).

Figure 3

Graph showing the Hypothesised Relation Between Eco-Guilt and Pro-Environmental Behaviour Including the Moderating Variable Education



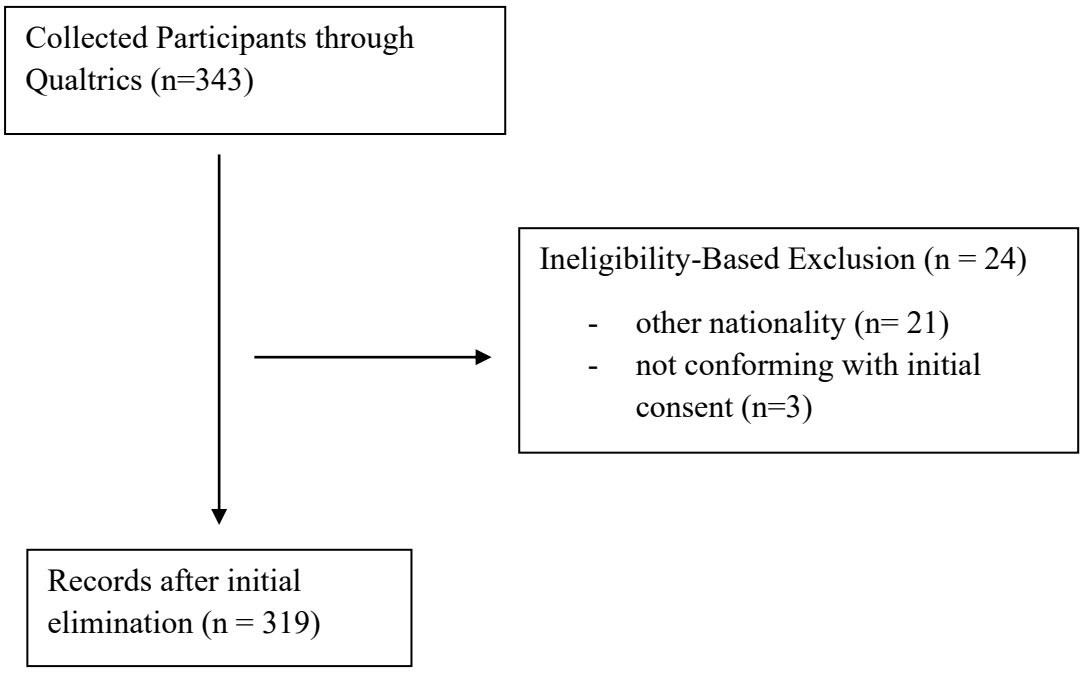
Results

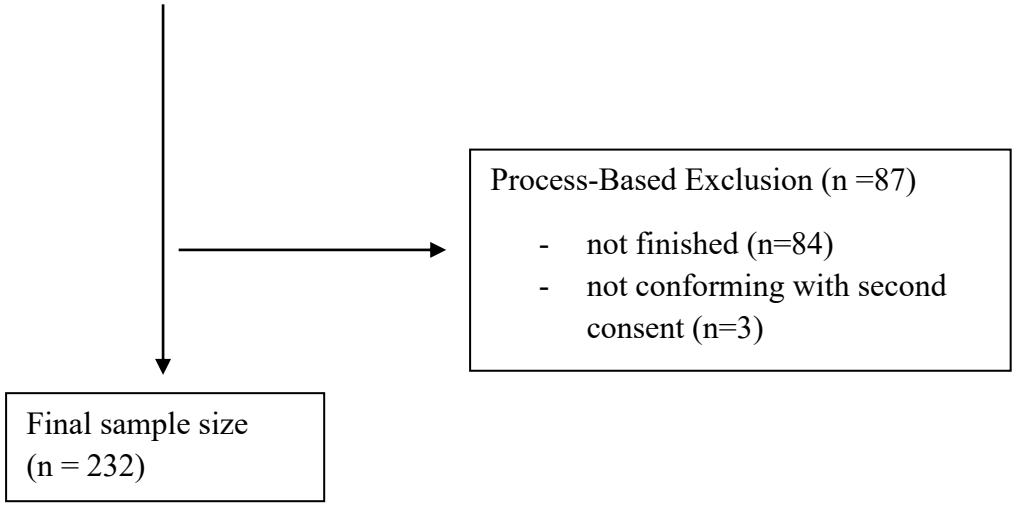
Demographics

The analysis of the survey data revealed that, out of 343 participants, a total of 111 (32.4%) were excluded. These exclusions were primarily due to participants who did not complete the questionnaire (n=84). Participants who reported having another nationality than German or Dutch (n=21) and those who did not provide consent for the initial (n=3) or subsequent informed consent (n=3) were also excluded. The final sample size for analysis comprised 232 participants. A graphical representation of the participant exclusion process can be viewed in Figure 4.

Figure 4

Flowchart of Participant Exclusion for the Analysis





The mean age of participants was 31.58 years (*SD* = 14.23) with an age range between 18 and 75. The Sociodemographic data can be viewed in Table 1. In terms of gender distribution, there were 84 male participants (36.2%), 146 female participants (63%), and 2 (0.9%) other/ non-binary participants. Moreover, the sample consisted of 120 German (51.7%) and 112 Dutch participants (48.3%).

Concerning education levels, 63 participants (27.1%) held a secondary education diploma, 70 (30.2%) had attained a bachelor's degree, and 36 participants (15.5%) had a college degree. Moreover, 29 individuals (12.5%) held a master's degree, while 19 (8.2%) had completed an apprenticeship. Additionally, 5 participants (2.1%) held a PhD or doctorate, and 10 individuals (4.3%) stated other qualifications. Notably, all participants completed high school.

Among those with other qualifications, five had a Diploma, which is comparable to a Master's degree, four had a State Examination, and one individual held the titles of "Meister" and "Techniker", which are vocational qualifications in Germany, typically achieved after completing specialized training programs and passing the examination.

Table 1

Sociodemographic Characteristics of Participants

Sociodemographic	

characteristic	*n*	%	*total*	*mean*	*sd*	*range*
Gender			232			
Female	146	63				
Male	84	36.2				
Non- binary	2	0.9				
Age				31.6	14.23	18 - 75
Educational level						
No High School Diploma	0	0				
High School Diploma	63	27.1				
Vocational diploma (Fachabitur)	36	15.5				
Apprenticeship	19	8.2				
Bachelor's degree	70	30.2				
Master's degree	29	12.5				
PhD / Doctorate	5	2.1				
Other	10	4.3				

Note. Out of 232 participants, 120 were German (51.7%) and 112 were Dutch (48.3%).

Linear Assumption Testing

The evaluation of linear models involves assessing several assumptions of normality, linearity, independence, and homoscedasticity. Figures and outputs related to these assessments can be found in the Appendix. The histograms of the residuals for Model 1 (Appendix D) indicate a skewed distribution, suggesting a violation of the normality assumption. This observation is further supported by the Shapiro-Wilk normality test ($p < 0.05$) suggesting a significant violation of normality. Similarly, the moderation model shows skewed residuals (see Appendix F) and the Shapiro-Wilk test result supported the violation of normality. The Breusch-Pagan test shows no violation of homoscedasticity for either model (see Appendix E). Plots of residuals versus fitted values (Appendix F) confirm the linearity of

both models. The study design ensures independence, with no clustering or dependencies in the observation.

Descriptive statistics

Table 2 presents the descriptive statistics for the two key variables. The EGuiQ-6 had a M = 2.20 with an SD = 0.68, which means a moderate level of eco-guilt among the participants. The scores ranged from 1 to 4. The PEBS showed a mean of 3.51 with an SD = 0.62 ranging from 1.64 to 4.76 which indicates a high level of pro-environmental behaviour across the participants. For the German sample, the mean for both variables were slightly higher than for the Dutch sample.

Table 2

Descriptive Statistics and Correlations of Variables

	n	***M***	***SD***	***min***	***max***	**1**	**2**
Overall	232						
1. EGuiQ – 11		2.20	0.68	1	4	—	
2. PEBS		3.51	0.62	1.64	4.76	.33**	—
German sample	120						
1. EGuiQ –11		2.31	0.68	1	4	—	
2. PEBS		3.68	0.57	2.30	4.76	.31**	—
Dutch sample	112						
1. EGuiQ - 11		2.10	0.67	1	3.54	—	
2. PEBS		3.33	0.62	1.64	4.37	.26*	—

Note. n = Number of Participants, M = Mean, SD = Standard Deviation, EGuiQ- 11= Eco-Guilt Questionnaire, PEBS = Pro-Environmental Behaviour Scale

*p < .05

** p < .001

Hypothesis 1

To test the first hypothesis, Spearman's Correlation Test was conducted. The output can be seen in Table 2. The results revealed a statistically significant positive correlation between eco-guilt and pro-environmental behaviour ($r=0.326$, $p<0.001$). These findings support the hypothesis that higher levels of eco-guilt are associated with higher scores on pro-environmental behaviour, indicating that individuals who score higher on eco-guilt tend to score higher in engaging in pro-environmental actions. In the German samples, the results revealed a moderate positive correlation between the two variables, which was statistically significant ($r=.316$, $p<0.001$). For the Dutch sample, the Spearman correlation test showed a weak significant positive correlation between the two variables ($r= .275$, $p< 0.05$). A visual representation of the overall correlation can be seen in Appendix G.

Hypothesis 2

To test the second hypothesis a Moderated Generalized Linear Model (GLM) was used. Based on the outcome there is insufficient evidence to support that education moderates the relationship between eco-guilt and pro-environmental behaviour (see Table 4). None of the education level coefficients were found to be statistically significant predictors of pro-environmental behaviour (all p-values > 0.05). Additionally, the interaction terms between eco-guilt and education levels did not yield significant effects on pro-environmental behaviour (all p-values > 0.05). Similar results were found when looking at only the German or Dutch subset. That indicates that there is no significant difference in the pro-environmental behaviour of participants based on their educational attainments, and higher educational levels do not strengthen the positive relationship between eco-guilt and pro-environmental behaviour. A visual representation of the predicted values of pro-environmental behaviour as a function of eco-guilt, separated by different levels of educational attainment can be seen in Appendix H.

Table 3

Moderated Multiple Regression Showing the Predictors of Pro-Environmental Behaviour

Variable	Estimate	*SE*	95% CI		*p*
			LL	*UL*	
(Intercept)	2.99	.26	2.46	3.51	.00
EcoGuilt (A)	.27	.11	.05	.48	.01
Apprenticeship (B)	-.45	.59	-1.61	.71	.44
Vocational Diploma (C)	-.32	.38	-1.07	.43	.40
Bachelor's Degree (D)	-.23	.37	-.96	.50	.53
Master's Degree (E)	.27	.43	-.58	1.12	.53
PhD / Doctorate (F)	-.59	.73	-2.04	.84	.41
Other (G)	-.40	.72	-1.82	1.01	.57
A x B	.19	.26	-0.32	.70	.46
A x C	.05	.16	-.27	.37	.74
A x D	.09	.15	-.21	.40	.54
A x E	-.22	.18	-.58	.14	.23
A x F	.06	.42	-.77	.90	.87
A x G	.23	.36	-.47	.94	.51

Note. CI = Confidence Interval; LL=Lower Level; UL=Upper Level. The intercept represents the reference category, "High School Diploma".

Discussion

This study builds on previous research exploring the emotional and psychological impacts of climate change on pro-environmental behaviour. By using the EGuiQ-11 and the PEBS that were recently translated, this research investigated the relationship between eco-guilt and pro-environmental behaviour in the German and Dutch populations. Furthermore, the impact of educational attainment on this relationship was explored.

Consistent with the first hypothesis, that individuals with higher levels of eco-guilt show higher levels of pro-environmental behaviour, the findings show that individuals who experienced more eco-guilt also performed more pro-environmental behaviour, thus confirming the first hypothesis. These findings are consistent with existing literature, which suggests that feelings of eco-guilt can serve as a motivator for individuals to engage in environmentally responsible actions (Rees et al., 2014; Iniguez-Gallardo et al., 2021).

However, the findings of this research do not establish the causal relationship and the long-term effectiveness of eco-guilt in promoting pro-environmental behaviour. Bamberg and Möser (2007) argue that guilt-induced behaviours may be superficial and short-lived, as individuals may quickly return to their habitual, less sustainable behaviours once the immediate feeling of guilt subsides. Additionally, a study by Hart et al. (2013) highlights that while guilt can motivate action, it can also provoke psychological resistance, especially if individuals feel overwhelmed or powerless to make significant environmental changes. That suggests that its use in encouraging pro-environmental behaviour should be carefully considered, as it can lead to an inverse effect and may negatively impact individuals' mental health.

The results from the moderated generalized model that was used for the second hypothesis indicated that educational levels do not moderate the relationship between eco-guilt and pro-environmental behaviour. This suggests that the influence of eco-guilt on pro-environmental behaviour does not significantly vary across different educational attainments, and higher educational attainment does not predict increased pro-environmental behaviour, thus leading to the rejection of the second hypothesis.

A potential explanation for the results could be the unequal distribution of participants across educational levels, which may have limited the statistical power to detect any moderating effect. While 70 participants reported having a Bachelor’s degree and 63 participants stated having a high school diploma only 5 out of 232 participants reported

having a PhD or Doctorate. Another explanation for these results may be that educational attainment alone does not necessarily predict that individuals with higher levels of eco-guilt will engage in more pro-environmental behaviour. Kollmuss and Agyemann (2002) suggest that longer education increases knowledge about environmental issues but that it does not imply an increased pro-environmental behaviour. Behaviour change is time-consuming and individuals with higher education levels might have less time due to demanding work or study schedules. Consequently, while eco-guilt can motivate pro-environmental behaviour as individuals might seek to reduce negative feelings of guilt, educational attainment may play an insignificant role in this relationship.

Limitations

The current study has several limitations affecting its validity and reliability. Firstly, the use of convenience and snowball sampling may introduce bias, as it is susceptible to selection bias and might result in a sample that does not represent the broader population (Parker et al., 2019). Given that no participant reported having less than a high school degree, the generalizability of the study is further limited, as it does not capture the perspectives of those with lower educational attainment.

Furthermore, the study's higher proportion of female participants (63%), could bias the findings, given that research suggests that females are more prone to experience climate change-related mental health effects and engage in pro-environmental behaviours (Moore & Yang, 2019; Ágoston et al.,2022b; Berry et al., 2018).

Moreover, the validity of the data in this study was weakened by the design of certain questionnaires used in the study, for example in the Pro-environmental Behaviour Scale, a question about the efficiency of the respondent's car was included that was only relevant to car owners. Because it was not feasible to distinguish between car owners and non-car owners, this question remained in the analysis to maintain the structure of the scale.

Lastly, the Eco-Guilt Questionnaire, along with the Eco-Anxiety and Eco-Grief Questionnaire (which were not used in this study), and the Pro-environmental Scale (PEBS) were newly translated into German and Dutch by Doyle (2024) and Gökoglan (2024). This translation factor could potentially influence the construct validity of the results, particularly if the meaning of the original questions were not accurately captured.

Strengths

Despite the various limitations, this study has several strengths worth mentioning. Eco-guilt, along with other eco-emotions such as eco-anxiety and eco-grief, are emerging concepts within the field of eco-psychology. This research contributes to this field by exploring factors that might influence the relationship between eco-guilt and pro-environmental behaviour. Given the inconsistent findings in previous studies and still numerous unexamined variables that may affect this relationship, this research serves as an initial attempt to study the complex interplay of eco-guilt, pro-environmental behaviour and educational attainment.

Furthermore, the focus on Dutch and German participants is particularly valuable, as both countries are leaders in environmental sustainability, as reported by the Climate Action Network Europe in 2018. While Germany is known for its Energiewende policy, promoting a transition to renewable energy (Egerer et al., 2018), the Netherlands is known for its innovative water management and sustainability practices (Van der Brugge et al., 2005). Studying eco-guilt levels and the influence on pro-environmental behaviours in individuals from these nations can show how the environmental practices of Germany and the Netherlands shape individual eco-guilt levels and environmental actions.

Implications for Future Research

From the limitations identified in this study, several considerations should be made for future research. Firstly, future studies could employ more diverse sampling strategies and focus on probability sampling methods. That would ensure a broader and more representative

participant pool (Lavrakas et al., 2019) and limit the bias introduced by snowball and convenience sampling.

Furthermore, future research should ensure a balanced representation of different educational backgrounds, including individuals without formal education and those with various degrees. By ensuring an equal distribution across levels of educational attainment, researchers can better investigate the impact education has on the relationship between eco-guilt and pro-environmental behaviour, therefore improving the reliability and generalizability of the study's findings.

Next, refining the design of the questionnaires would enhance the reliability of responses. For instance, the questionnaires should be designed in such a way that participants have the option to skip questions that do not apply to them. That would improve the quality of the data.

Moreover, besides education as a factor, future research should incorporate other aspects that could moderate or mediate the relationship between eco-guilt on pro-environmental behaviour. These aspects might include other demographics, or internal values like motivation or social norms like the expectation of the communities, as they can provide a better understanding of the mechanisms that influence this relationship. It is essential to consider both, the positive and negative psychological impacts of eco-guilt to understand how it motivates sustainable behaviour. This understanding can identify factors that enhance the effectiveness of eco-guilt in promoting sustainability, rather than causing people to feel overwhelmed and unable to act.

Lastly, future research should focus on identifying the specific factors that drive pro-environmental behaviour. Implementing for instance interview studies can help uncover the reasons why individuals who experience eco-guilt engage in these behaviours. While this study only focused on identifying the correlation between both variables, future studies are needed to get insights into the underlying motivations of individuals.

Conclusion

This study explored the mental health impacts of climate change, focusing on the influence of eco-guilt on pro-environmental behaviour and the moderating role of educational attainment among adults in Germany and the Netherlands.

Through a cross-sectional study, the EGuiQ-11 and the PEBS were applied to German and Dutch populations to examine the moderating effect of educational attainment on the relationship between Eco-Guilt and Pro-environmental behaviour.

The results indicated that eco-guilt was positively correlated with pro-environmental behaviour, consistent with existing literature that posits eco-guilt as a motivational factor for environmentally responsible actions. No significant moderation effect of educational attainment was found, which can be due to the fact that school education alone may not account for different levels of pro-environmental behaviour and does not impact the influence of eco-guilt on pro-environmental behaviours.

Future studies should focus on employing for instance more diverse sampling methods, a broader and equally distributed population in terms of educational attainment and focus on qualitative research studies to examine the underlying mechanism that impacts the relationship of eco-guilt and pro-environmental behaviour.

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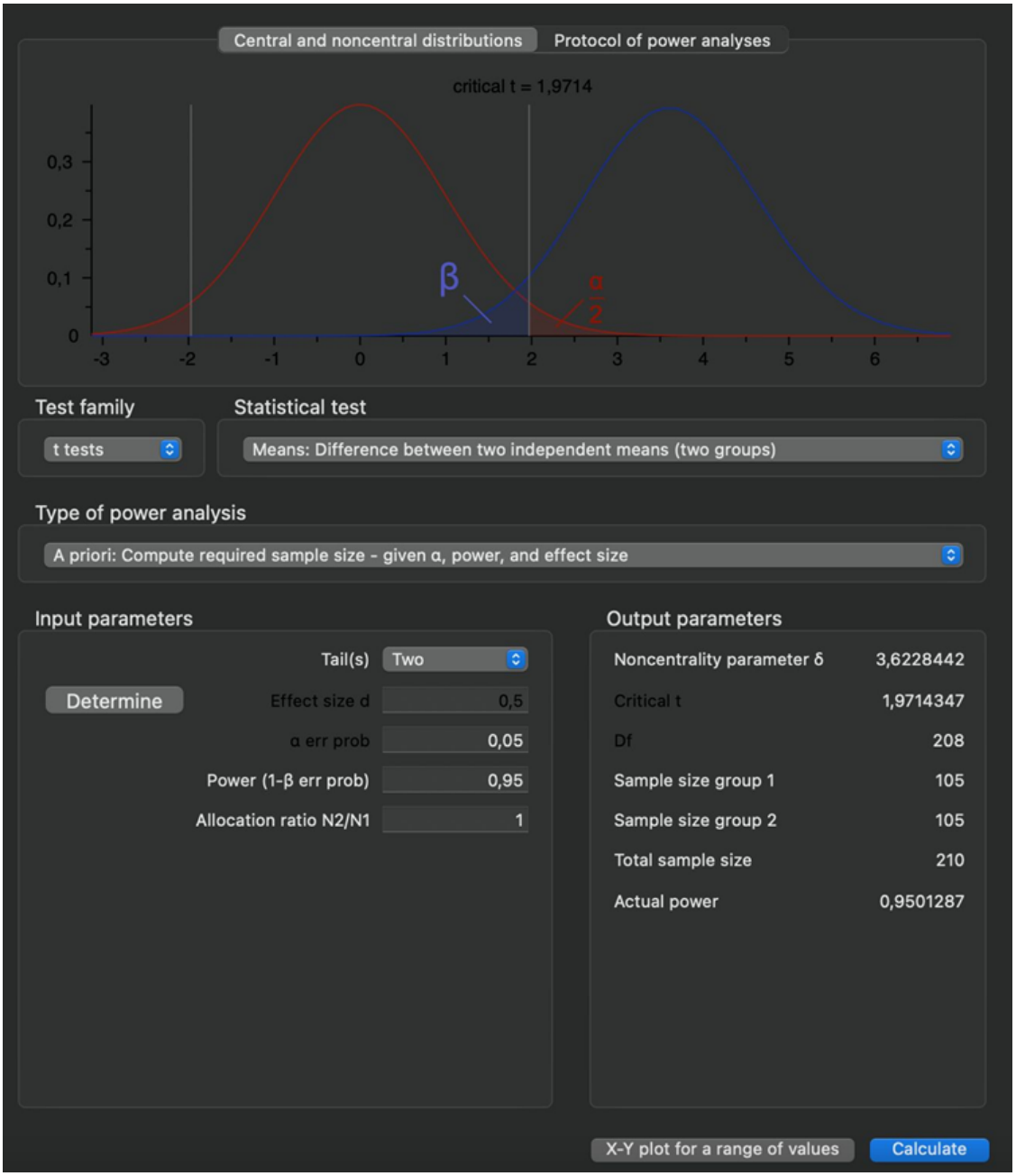
Appendices

Appendix A: STROBE Statement-checklist

	Item No	Recommendation
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found
Introduction		
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported
Objectives	3	State specific objectives, including any prespecified hypotheses
Methods		
Study design	4	Present key elements of study design early in the paper
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection
Participants	6	(*a*) *Cohort study*—Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up *Case-control study*—Give the eligibility criteria, and the sources and methods of case ascertainment and control selection. Give the rationale for the choice of cases and controls *Cross-sectional study*—Give the eligibility criteria, and the sources and methods of selection of participants
		(*b*) *Cohort study*—For matched studies, give matching criteria and number of exposed and unexposed *Case-control study*—For matched studies, give matching criteria and the number of controls per case
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group
Bias	9	Describe any efforts to address potential sources of bias
Study size	10	Explain how the study size was arrived at
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding
		(*b*) Describe any methods used to examine subgroups and interactions
		(*c*) Explain how missing data were addressed
		(*d*) *Cohort study*—If applicable, explain how loss to follow-up was addressed *Case-control study*—If applicable, explain how matching of cases and controls was addressed *Cross-sectional study*—If applicable, describe analytical methods taking

		account of sampling strategy
		(*e*) Describe any sensitivity analyses
Results		
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed
		(b) Give reasons for non-participation at each stage
		(c) Consider use of a flow diagram
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders
		(b) Indicate number of participants with missing data for each variable of interest
		(c) *Cohort study*—Summarise follow-up time (eg, average and total amount)
Outcome data	15*	*Cohort study*—Report numbers of outcome events or summary measures over time
		Case-control study—Report numbers in each exposure category, or summary measures of exposure
		Cross-sectional study—Report numbers of outcome events or summary measures
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included
		(*b*) Report category boundaries when continuous variables were categorized
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses
Discussion		
Key results	18	Summarise key results with reference to study objectives
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence
Generalisability	21	Discuss the generalisability (external validity) of the study results
Other information		
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based

Appendix B: G*Power calculation for Sample Size



Appendix C: Advertisement for the study

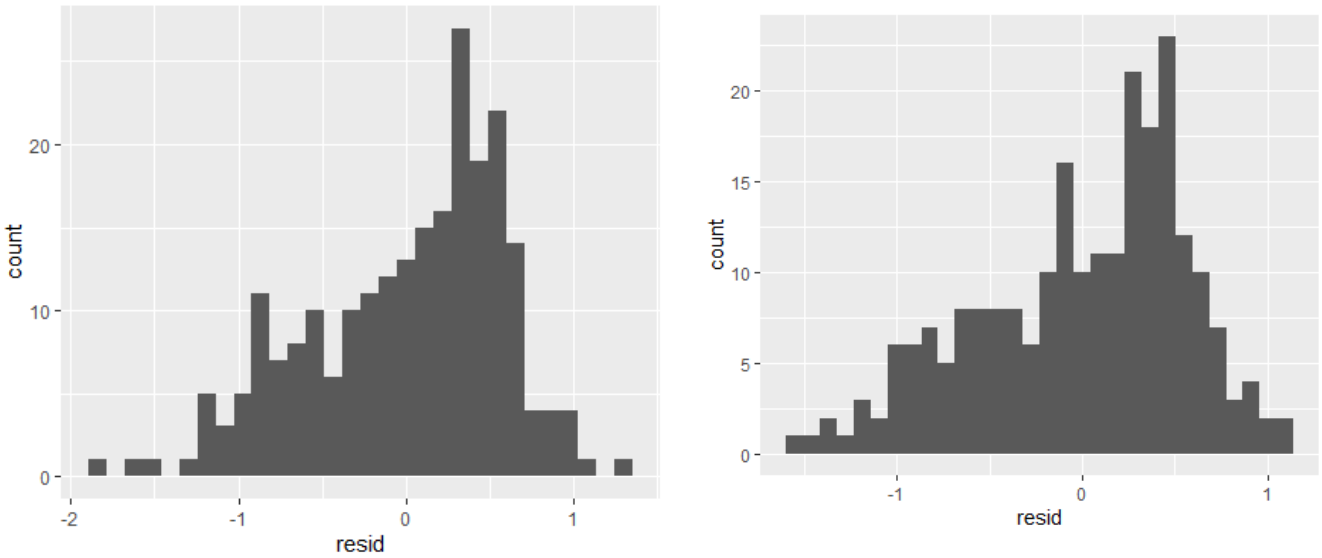

Was sind die psychischen Auswirkungen des Klimawandels?
Neugierig? Dann werde Teil meiner Studie, bei der ich genau das herausfinden will!
Du bist mindestens 18 Jahre alt und sprichst Deutsch oder Niederländisch?
Super! Dann erfüllst Du alle Teilnahmebedingungen!
Was sind die psychischen Auswirkungen des Klimawandels?
Neugierig?
Dann werde Teil meiner Studie, bei der ich genau das herausfinden will!
Du bist mindestens 18 Jahre alt und sprichst Deutsch oder Niederländisch?
Super! Dann erfüllst Du alle Teilnahmebedingungen!

Appendix D: Normality Assumption Testing

Figure D1

Histogram of the residuals for each model

A **B**



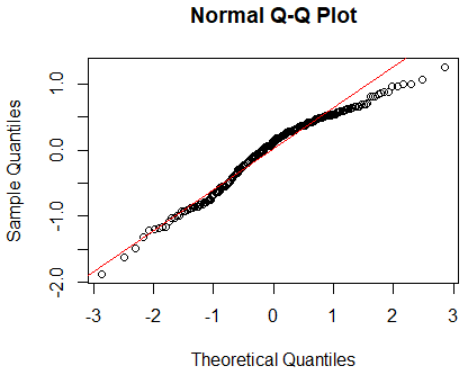
Note. Plot A shows the histogram of the linear model, Plot B shows the histogram of the moderation model

Figure D2

Shapiro-Wilk and Q-Q Plot for both models

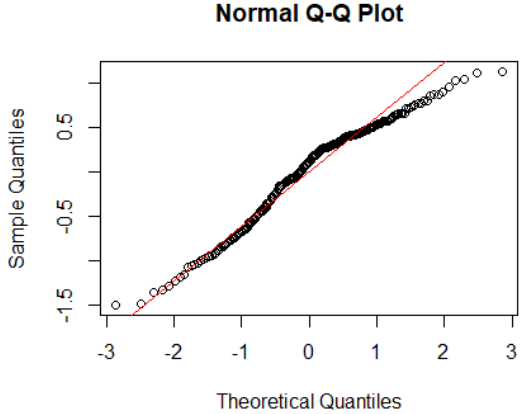
A) Shapiro-Wilk normality test

```
data:  model_EcoPEBS$residuals
W = 0.96377, p-value = 1.266e-05
```



B) Shapiro- Wilk Test for Regression Model with interaction

```
data:  Model_mod$residuals
  W = 0.9648, p-value = 1.7e-05
```



Note. A shows the Shapiro-Wilk normality test and Q-Q Plot of the linear model, B shows it of the moderation model

Appendix E: Homoscedasticity Assumption

Breusch-Pagan test

Model 1

```
data:  variance1
BP = 3.3239, df = 1, p-value = 0.06828
```

Model 2

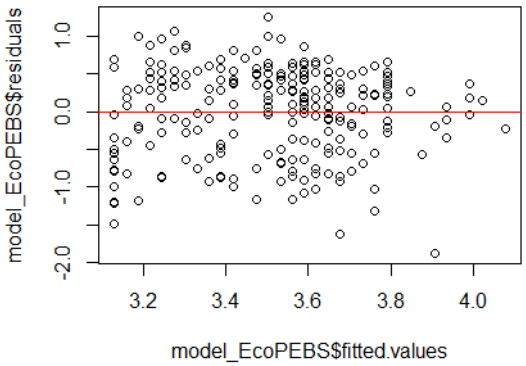
```
data:  moderation
BP = 19.931, df = 13, p-value = 0.09694
```

Appendix F: Linearity Assumption

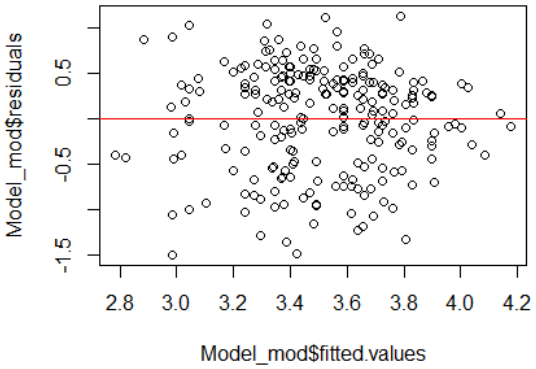
Figure F1

Plots of the Residuals vs Fitted values

A)



B)

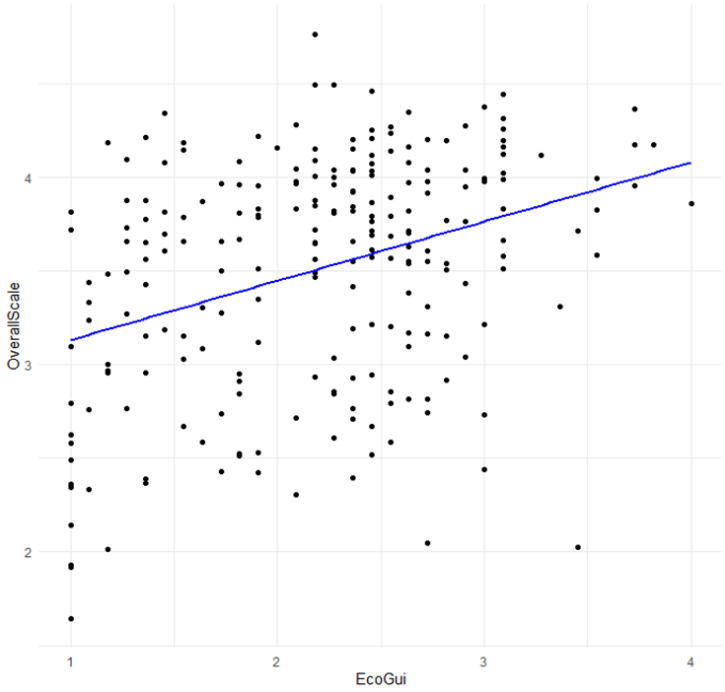


Note. A shows the Residuals vs. Fitted Plot of the linear model, B shows it of the moderation model

Appendix G: Correlation

Figure G1

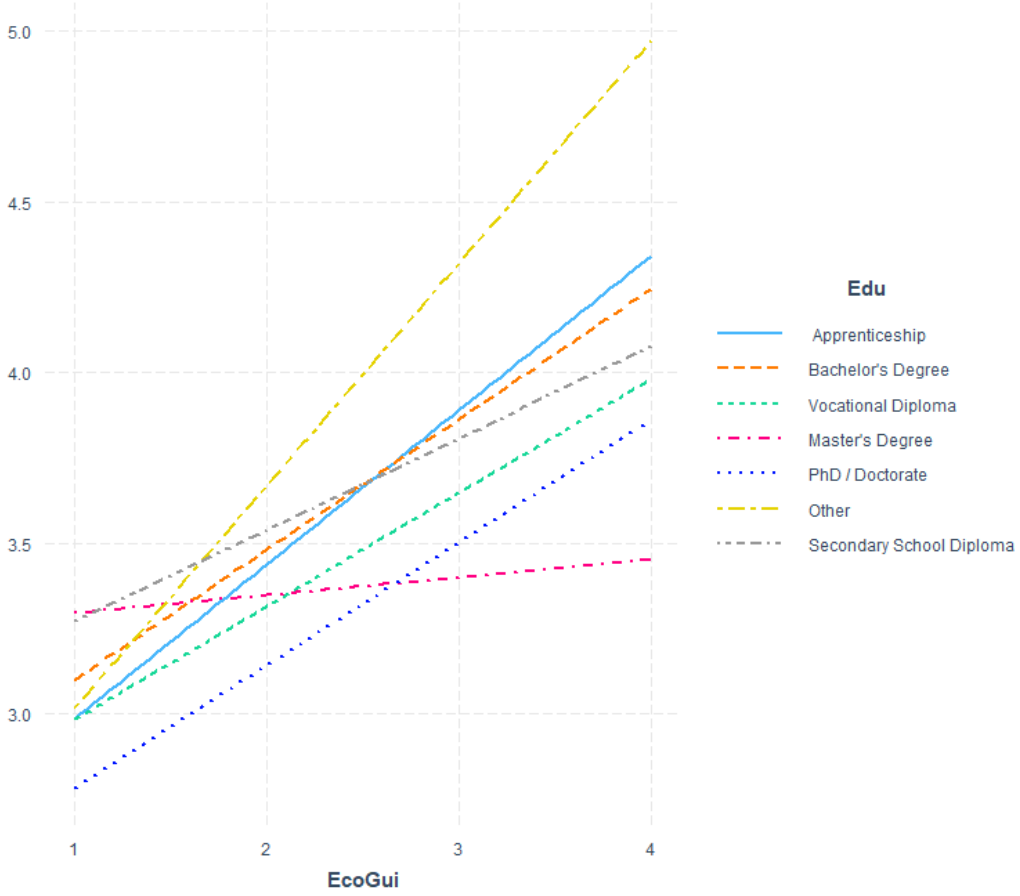
Scatterplot with Spearman's Rank Correlation



Appendix H: Moderation

Figure H1

Predicted Values Of Eco-Guilt on Pro-Environmental Behaviour, Separated by Education



Appendix I: Opening Statements of Survey in Qualtrics

German Version

Willkommen
Das Ziel dieser Studie ist es, den Zusammenhang zwischen Klimawandel, psychischen Störungen und umweltfreundlichem Verhalten in der deutschen und niederländischen Bevölkerung zu untersuchen.

Teilnahme
Um an dieser Studie teilnehmen zu können, müssen Sie mindestens 18 Jahre alt sein und entweder in Deutschland oder den Niederlanden leben. Ausserdem müssen Sie entweder deutsch oder niederländisch sprechen. Personen, die derzeit in Behandlung einer psychischen Krankheit sind oder in den letzten zwei Jahren suizidale Gedanken hatten, können nicht an dieser Studie teilnehmen, um sie vor möglichen Schäden durch die Teilnahme zu schützen. Ihre Teilnahme an dieser Studie ist vollkommen freiwillig, und Sie haben das Recht, jederzeit ohne Angabe von Gründen oder ohne Konsequenzen zurückzutreten. Alle bis dahin von Ihnen bereitgestellten Daten werden von weiteren Analysen ausgeschlossen. Nach Abschluss des Fragebogens werden jedoch alle Daten anonymisiert und sind daher nicht identifizierbar, was eine Löschung der Daten unmöglich macht. Die Verwendung Ihrer Daten erfolgt ausschliesslich unter vertraulichen Umständen. Nach der Zustimmung zur Teilnahme werden demografische Fragen gestellt. Um Anonymität zu gewährleisten, werden keine identifizierbaren Informationen gesammelt. Der Fragebogen dauert etwa 15-20 Minuten. Ihre Teilnahme an dieser Studie wird sehr geschätzt und wird dazu beitragen, unser Verständnis der psychologischen Auswirkungen des Klimawandels zu vertiefen.

Dutch Version

Welkom
Het doel van dit onderzoek is om de relatie tussen klimaatverandering, psychische stoornissen en milieuvriendelijk gedrag in de Duitse en Nederlandse bevolking te onderzoeken.
Deelname
Om deel te nemen aan dit onderzoek moet u 18 jaar of ouder zijn en in Duitsland of Nederland wonen. U moet ook Duits of Nederlands spreken. Mensen die momenteel onder behandeling zijn voor een psychische aandoening of die de afgelopen twee jaar suïcidale gedachten hebben gehad, kunnen niet deelnemen aan dit onderzoek om hen te beschermen tegen mogelijke schade door deelname. Uw deelname aan dit onderzoek is geheel vrijwillig en u heeft het recht om u op elk moment terug te trekken zonder opgaaf van reden of consequenties. Alle gegevens die u tot op dat moment hebt verstrekt, worden uitgesloten van verdere analyses. Zodra de vragenlijst is ingevuld, worden alle gegevens echter geanonimiseerd en kunnen ze dus niet meer worden geïdentificeerd, waardoor het onmogelijk is om uw gegevens te verwijderen. Uw gegevens worden uitsluitend onder vertrouwelijke omstandigheden gebruikt. Demografische vragen worden gesteld zodra u hebt ingestemd met deelname. Om anonimiteit te garanderen, wordt er geen identificeerbare informatie verzameld. Het invullen van de vragenlijst duurt ongeveer 15-20 minuten. Uw deelname aan

dit onderzoek wordt zeer op prijs gesteld en zal bijdragen aan een beter begrip van de psychologische gevolgen van klimaatverandering.

Appendix J: Informed Consent in Qualtrics

German Version

Indem ich unten auf JA klicke, bestätige ich das Folgende:
Ich habe alle Informationen gelesen und erfülle alle Teilnahmebedingungen. Ich bestätige, dass meine Teilnahme völlig freiwillig ist. Ich erkenne auch mein Recht an, meine Einwilligung jederzeit ohne Angabe von Gründen zu widerrufen, insbesondere wenn ich Unbehagen oder Stress jeglicher Form empfinde. Solch Widerruf wird keine Konsequenzen nach sich ziehen.

Darüber hinaus verstehe ich Folgendes:
- Alle vom Forscher erhobenen Daten bleiben völlig anonym und können nicht auf meine Identität zurückgeführt werden. Ein Rücktritt ist daher nach Beendigung der Umfrage nicht mehr möglich.
- Mir ist bekannt, dass die von mir zur Verfügung gestellten Informationen in Forschungsberichten verwendet werden, deren Ziel es ist, die Auswirkungen des Klimawandels auf die psychische Gesundheit darzustellen.
- Ich befinde mich derzeit in KEINER medizinischen oder therapeutischen Behandlung aufgrund einer psychischen Störung.
- Ich habe in den letzten zwei Jahren KEINE Selbstmordgedanken erfahren.
- Mir ist bewusst, dass die Teilnahme an der Studie aufgrund der Diskussion der sensiblen Thematik des Klimawandels zu psychischem Unbehagen führen kann.
- Ich erkläre mich damit einverstanden, keine Informationen über den Ablauf und die Einzelheiten der Studie zu teilen, da dies die Ergebnisse der Studie beeinträchtigen könnte.
- Ich erkläre mich damit einverstanden, dass meine Antworten in der Umfragedatenbank für mögliche zukünftige Forschungs- und Ausbildungszwecke genutzt werden.

Dutch Version

Door hieronder op JA te klikken, bevestig ik het volgende:
Ik heb alle informatie gelezen en voldoe aan alle deelnamevoorwaarden. Ik bevestig dat mijn deelname volledig vrijwillig is. Ik erken ook mijn recht om mijn medewerking aan dit onderzoek op elk moment in te trekken zonder opgave van reden, vooral als ik ongemak of stress van welke vorm dan ook ervaar. Een dergelijke intrekking heeft geen gevolgen.

Daarnaast begrijp ik het volgende:
- Alle door de onderzoekers verzamelde gegevens blijven volledig anoniem en zijn niet te herleiden tot mijn identiteit. Na afloop van de enquête is terugtrekking dus niet meer mogelijk.
- Ik begrijp dat de informatie die ik verstrek zal worden gebruikt in onderzoeksrapporten die tot doel hebben de impact van klimaatverandering op de psychische gezondheid aan te tonen.
- Ik onderga momenteel GEEN medische of therapeutische behandeling voor een psychische stoornis.
- Ik heb de afgelopen twee jaar GEEN zelfmoordgedachten gehad.

- Ik ben mij ervan bewust dat deelname aan het onderzoek psychologisch ongemak kan veroorzaken als gevolg van de discussie over de gevoelige kwestie van klimaatverandering.
- Ik ga ermee akkoord geen informatie te delen over het proces en de details van het onderzoek, aangezien dit de resultaten van het onderzoek zou kunnen beïnvloeden.
- Ik ga ermee akkoord dat mijn antwoorden worden gebruikt in de enquêtedatabase voor mogelijk toekomstig onderzoeks- en trainingsdoeleinden.

Appendix K: R-Code

```
install.packages("tidyverse")
library(tidyverse)
install.packages("dplyr")
library(dplyr)
install.packages("knitr")
library(knitr)
install.packages ("ggplot2")
library(ggplot2)
install.packages ("psych")
library(psych)
install.packages ("lavaan")
library(lavaan)
install.packages ("stats")
library(stats)
install.packages("jtools")
install.packages("gridExtra")
library(jtools)
library(gridExtra)
library(modelr)
install.packages("lmtest")
library(lmtest)
install.packages("interaction")
library(interaction)


# Get the current working directory
current_directory <- getwd()
# print the current working directory
print(current_directory)
#import dataset
datafull <- read.csv("Updated_Climate.csv")
```

```
# clean the data

# Filter participants

filtered_data <- datafull[datafull$Finished == "True",]

filtered_data <- filtered_data[filtered_data$X2nd.consent == "Ja",]


#delete datasecurity columns

colums_to_delete <-c("StartDate","EndDate", "Status",
"Progress","Duration..in.seconds.","Finished","RecordedDate", "ResponseId",
"DistributionChannel")

filtered_data <- select(filtered_data,-one_of(colums_to_delete))


#dataset for demographics

demographics_data <-filtered_data[,3:7]

#analyse demographics

gender_counts <- table(demographics_data$Geschlecht)

print(gender_counts)

nationality <- table(demographics_data$nationality)

print(nationality)

Education <- table (demographics_data$Bildungsabschluss)

print(Education)

demographics_data$Alter.<- as.numeric(demographics_data$Alter.)

mean_Alter <-mean(demographics_data$Alter.)

mean_Alter

sd(demographics_data$Alter.)

age_range <-range(demographics_data$Alter.)

print(age_range)

# frequency plot for Age distribution

demographics_data %>%

  ggplot(aes(x = Alter.)) +

  geom_freqpoly()

#boxplot for age and education

demographics_data%>%

  mutate(Bildungsabschluss= factor(Bildungsabschluss)) %>%
```

```
  ggplot(aes(x = Bildungsabschluss, y = Alter.)) +
  geom_boxplot()
#Education statistics
education_counts <- table(filtered_data$Bildungsabschluss)
print(education_counts)
#calculate the percentage of each education level
education_percentages <-
  prop.table(education_counts)*100
print(education_percentages)

barplot(education_counts,
        main ="Education Levels",
        xlab = "Education Level",
        ylab = "Frequency")

#creating scales
cols_to_recode <- 41:51
filtered_data <- filtered_data %>%
  mutate(across(cols_to_recode, ~ case_when(
    . == "stimme nicht zu" ~ 1,
    . == "stimme eher nicht zu" ~ 2,
    . == "stimme eher zu" ~ 3,
    . == "stimme zu" ~ 4,
    TRUE ~ NA_real_
  )))
filtered_data <- filtered_data %>%
  mutate(EcoGui = rowMeans(select(., cols_to_recode), na.rm = TRUE))

cols_to_recode <- c(81:86, 87)
filtered_data <- filtered_data %>%
  mutate(across(cols_to_recode, ~ case_when(
    . %in% c("nie", "heiÃY") ~ 1,
```

```
    . %in% c("selten") ~ 2,
    . %in% c("manchmal", "warm") ~ 3,
    . %in% c("hÃ¤ufig") ~ 4,
    . %in% c("immer", "kalt") ~ 5,
    TRUE ~ NA_real_
  ))) %>%
  mutate(Cons = rowMeans(select(., cols_to_recode), na.rm = TRUE))
cols_to_recode <- c(88:93)
filtered_data <- filtered_data %>%
  mutate(across(cols_to_recode, ~ case_when(
    . %in% c("nein", "nie", "24 oder weniger") ~ 1,
    . %in% c("selten", "25-29") ~ 2,
    . %in% c("manchmal", "30-34") ~ 3,
    . %in% c("oft","35-39") ~ 4,
    . %in% c("ja", "stÃ¤ndig", "40 oder mehr") ~ 5,
    TRUE ~ NA_real_
  ))) %>%
  mutate(EnvCit = rowMeans(select(., cols_to_recode), na.rm = TRUE))
cols_to_recode <- c(94:96)
filtered_data <- filtered_data %>%
  mutate(across(cols_to_recode, ~ case_when(
    . %in% c("nein") ~ 1,
    . %in% c("ja", "ich esse kein Rindfleisch/ Schweinefleisch/ GeflÃ¼gel") ~ 5,
    TRUE ~ NA_real_
  ))) %>%
  mutate(Food = rowMeans(select(., cols_to_recode), na.rm = TRUE))
cols_to_recode <- c(97:99)
filtered_data <- filtered_data %>%
  mutate(across(cols_to_recode, ~ case_when(
    . %in% c("nie") ~ 1,
    . %in% c("gelegentlich") ~ 3,
    . %in% c("hÃ¤ufig") ~ 5,
```

```
    TRUE ~ NA_real_
  ))) %>%
  mutate(Trans = rowMeans(select(., cols_to_recode), na.rm = TRUE))


#create dataset with new variables
CoolData <- data.frame(
  EcoGui = filtered_data$EcoGui,
  Cons = filtered_data$Cons,
  EnvCit = filtered_data$EnvCit,
  Food = filtered_data$Food,
  Trans = filtered_data$Trans,
  Edu = filtered_data$Bildungsabschluss,
  Natio = filtered_data$nationality)
CoolData <- CoolData %>%
  rowwise() %>%
  mutate(OverallScale = sum(c(Cons, EnvCit, Food, Trans), na.rm = TRUE))
CoolData$OverallScale <- CoolData$OverallScale / 4

# create dataset for dutch and german
CoolData_german <- CoolData[CoolData$Natio == "Deutsch",]
CoolData_dutch <- CoolData[CoolData$Natio == "NiederlÃ¤ndisch",]

#create specific datasets
table(filtered_data$Geschlecht)
table(filtered_data$Alter.)
filtered_data$Alter. <- as.numeric(filtered_data$Alter.)
hist(filtered_data$Alter., main = "Age Distribution", xlab = "age")
table(filtered_data$nationality)
table(filtered_data$Bildungsabschluss)
barplot(table(filtered_data$Bildungsabschluss), main = "Education Distribution", xlab =
"Bildungsabschluss")
table_counts <- table(filtered_data$Bildungsabschluss)
table_output <- kable(table_counts, caption = "Distribution of level_ed")
```

```
print(table_output)
#descriptive statistics
mean(CoolData$EcoGui)
sd(CoolData$EcoGui)
range(CoolData$EcoGui)
CoolData <- CoolData %>%
  rowwise() %>%
  mutate(OverallScale = sum(c(Cons, EnvCit, Food, Trans), na.rm = TRUE))
CoolData$OverallScale <- CoolData$OverallScale / 4
mean(CoolData$OverallScale)
sd(CoolData$OverallScale)
range(CoolData$OverallScale)
frequency_table <- table(CoolData$Edu)
print(frequency_table)
proportion_table <- prop.table(table(CoolData$Edu))
print(proportion_table)
barplot(table(CoolData$Edu), main= "Frequency of Categories", xlab= "Categories", ylab=
"Frequency")
#descriptive statistic German
mean(CoolData_german$EcoGui)
sd(CoolData_german$EcoGui)
range(CoolData_german$EcoGui)
mean(CoolData_german$OverallScale)
sd(CoolData_german$OverallScale)
range(CoolData_german$OverallScale)
frequency_table <- table(CoolData_german$Edu)
print(frequency_table)
proportion_table <- prop.table(table(CoolData_german$Edu))
print(proportion_table)
barplot(table(CoolData_german$Edu), main= "Frequency of Categories", xlab= "Categories",
ylab= "Frequency")
#descriptive statistic Dutch
mean(CoolData_dutch$EcoGui)
```

```
sd(CoolData_dutch$EcoGui)
range(CoolData_dutch$EcoGui)
mean(CoolData_dutch$OverallScale)
sd(CoolData_dutch$OverallScale)
range(CoolData_dutch$OverallScale)
frequency_table <- table(CoolData_dutch$Edu)
print(frequency_table)
proportion_table <- prop.table(table(CoolData_dutch$Edu))
print(proportion_table)
barplot(table(CoolData_dutch$Edu), main= "Frequency of Categories", xlab= "Categories",
ylab= "Frequency")
#Assumption Testing 1 hypothesis
model_EcoPEBS <- CoolData %>%
  lm(OverallScale ~ EcoGui, data = .)
CoolData %>%
  add_residuals(model_EcoPEBS) %>%
  ggplot(aes(x= resid)) +
  geom_histogram()
#Linearity
plot(model_EcoPEBS$fitted.values,
     model_EcoPEBS$residuals)
abline(h = 0, col = "red")
#Normality Q-Q Plot
qqnorm(model_EcoPEBS$residuals)
qqline(model_EcoPEBS$residuals, col = "red")
#Shapiro-Wilk Test
shapiro.test(model_EcoPEBS$residuals)
# Breusch Pagan test
variance1 <-lm(OverallScale ~ EcoGui, data = CoolData)
bptest(variance1)
#make a table
EcoPEBS.table <- tidy(model_EcoPEBS, conf.int = TRUE)
EcoPEBS.table
```

```
#make the log because of non normal distribution
CoolData$log_OverallScale <- log(CoolData$OverallScale)
model_with_log <- lm(log_OverallScale ~ EcoGui, data = CoolData)
#extract residuals
residuals_with_log <- residuals(model_with_log)
#visual check
hist(residuals_with_log, main = "Histogram of Residuals (with Log Transformation)",
xlab="Residuals")

#try square root
CoolData$sqrt_OverallScale <- sqrt(CoolData$OverallScale)
model_with_sqrt <- lm(sqrt_OverallScale ~ EcoGui, data = CoolData)
residuals_with_sqrt <- residuals(model_with_sqrt)
shapiro.test(residuals_with_sqrt)
#shapiro test
shapiro.test(residuals_with_log)

#correlation between variables
#Hypothesis 1
cor.test(CoolData$EcoGui, CoolData$OverallScale,
        method= "spearman",
        exact= FALSE,
        alternative = "greater")
cor(CoolData$EcoGui, CoolData$OverallScale, method ="spearman")
#hypothesis 1 German
cor.test(CoolData_german$EcoGui, CoolData_german$OverallScale,
        method= "spearman",
        exact= FALSE,
        alternative = "greater")
#hypothesis 1 Dutch
cor.test(CoolData_dutch$EcoGui, CoolData_dutch$OverallScale,
        method = "spearman",
        exact = FALSE,
```

```
        alternative = "greater")

# Create a scatter plot with a trend line
ggplot(CoolData, aes(x = EcoGui, y = OverallScale)) +
  geom_point() +
  geom_smooth(method = "lm", se = FALSE, color = "blue") +
  labs(title = "Scatter Plot with Spearman's Rank Correlation",
       x = "EcoGui",
       y = "OverallScale") +
  theme_minimal()
# German
ggplot(CoolData_german, aes(x = EcoGui, y = OverallScale)) +
  geom_point() +
  geom_smooth(method = "lm", se = FALSE, color = "blue") +
  labs(title = "Scatter Plot with Spearman's Rank Correlation",
       x = "EcoGui",
       y = "OverallScale") +
  theme_minimal()
# Dutch
ggplot(CoolData_dutch, aes(x = EcoGui, y = OverallScale)) +
  geom_point() +
  geom_smooth(method = "lm", se = FALSE, color = "blue") +
  labs(title = "Scatter Plot with Spearman's Rank Correlation",
       x = "EcoGui",
       y = "OverallScale") +
  theme_minimal()

#Testing second hypothesis
CoolData$Edu <- as.factor(CoolData$Edu)
levels(CoolData$Edu)
#rename level
levels(CoolData$Edu)[levels(CoolData$Edu) == "WeiterfÃ¼hrender Schulabschluss (Haupt-
,Realschulabschluss, Abitur)"] <-"Secondary School Diploma"
```

```
levels(CoolData$Edu)[levels(CoolData$Edu) == "Ausbildung"] <-" Apprenticeship"
levels(CoolData$Edu)[levels(CoolData$Edu) == "Fachhochschule"] <-"Vocational Diploma"
levels(CoolData$Edu)[levels(CoolData$Edu) == "Bachelorabschluss"] <-"Bachelor's Degree"
levels(CoolData$Edu)[levels(CoolData$Edu) == "Masterabschluss"] <-"Master's Degree"
levels(CoolData$Edu)[levels(CoolData$Edu) == "PhD / Doktortitel"] <-"PhD / Doctorate"
levels(CoolData$Edu)[levels(CoolData$Edu) == "Sonstiges, bitte angeben"] <-"Other"

#model Moderation
MM<- lm(OverallScale ~ EcoGui * Edu, data =CoolData)
summary(MM)
CoolData %>%
  add_residuals(MM) %>%
  ggplot(aes(x= resid)) +
  geom_histogram()
#Linearity
plot(MM$fitted.values,
     MM$residuals)
abline(h = 0, col = "red")
#Normality Q-Q Plot
qqnorm(MM$residuals)
qqline(MM$residuals, col = "red")
#Shapiro-Wilk Test
shapiro.test(MM$residuals)

#make the log because of non normal distribution
CoolData$log_OverallScale <- log(CoolData$OverallScale)
MM_with_log <- lm(log_OverallScale ~ EcoGui *Edu, data = CoolData)
#extract residuals
residuals_with_log <- residuals(MM_with_log)
#visual check
hist(residuals_with_log, main = "Histogram of Residuals (with Log Transformation)",
xlab="Residuals")
```

```
#try square root
CoolData$sqrt_OverallScale <- sqrt(CoolData$OverallScale)
MM_with_sqrt <- lm(sqrt_OverallScale ~ EcoGui * Edu, data = CoolData)
residuals_with_sqrt <- residuals(MM_with_sqrt)
shapiro.test(residuals_with_sqrt)
#shapiro test
shapiro.test(residuals_with_log)



#generalizedModeration Model
Model_mod <- glm(OverallScale ~ EcoGui * Edu, data= CoolData)
summary(Model_mod)
#with different family
Model_mod_f <- glm(OverallScale~ EcoGui * Edu, data = CoolData, family =gaussian(link =
"identity"))
summary(Model_mod_f)
Model_mod_german <- glm(OverallScale ~ EcoGui* Edu, data= CoolData_german)
summary(Model_mod_german)
Model_mod_Dutch <- glm(OverallScale ~ EcoGui * Edu, data= CoolData_dutch)
summary(Model_mod_Dutch)
#Assumptions Linearity and Homoskedasticity
plot(Model_mod$fitted.values,
    Model_mod$residuals)
abline(h=0, col= "red")
# Assumption Normality
qqnorm(Model_mod$residuals)
qqline(Model_mod$residuals, col= "red")
shapiro.test(Model_mod$residuals)
#Check homoscedasticity
bptest(Model_mod)

#plot interaction effects
install.packages("interactions")
```

```
library(interactions)
interact_plot(Model_mod, pred = EcoGui, modx= Edu)

#visualize distribution of OverallScale
ggplot(CoolData, aes(x = OverallScale)) +
  geom_histogram(bins = 30, fill = 'blue', alpha = 0.7) +
  theme_minimal() +
  labs(title = "Histogram of OverallScale")
install.packages("e1071")
library(e1071)
skewness <- e1071::skewness(CoolData$OverallScale)
print(paste("Skewness of OverallScale:", skewness))

# Apply square transformation
CoolData$OverallScale_transformed <- CoolData$OverallScale^2

# Visualize the transformed data
ggplot(CoolData, aes(x = OverallScale_transformed)) +
  geom_histogram(bins = 30, fill = 'green', alpha = 0.7) +
  theme_minimal() +
  labs(title = "Histogram of Transformed OverallScale")

# Q-Q plot for transformed OverallScale
qqPlot(CoolData$OverallScale_transformed, main = "Q-Q Plot of Transformed
OverallScale")

# Calculate and print skewness for transformed OverallScale
skewness_transformed <- e1071::skewness(CoolData$OverallScale_transformed)
print(paste("Skewness of Transformed OverallScale:", skewness_transformed))
ggplot(data.frame(residuals), aes(x = residuals)) +
  geom_histogram(bins = 30, fill = 'red', alpha = 0.7) +
  theme_minimal() +
  labs(title = "Histogram of Residuals")
```

```
# Q-Q plot of residuals
qqPlot(residuals, main = "Q-Q Plot of Residuals")

# Perform Shapiro-Wilk test for normality of residuals
shapiro.test(residuals)
```