Expaining Atheism Preregistration: Pilot 1, Cognitive Style and Non-verbal Reasoning

INSERT DATE

# Study Information

## Title

EA Preregistration Pilot 1: Cognitive Style & Non-Verbal Reasoning

## Description

This preregistration is part of a number of preregistrations for the Explaining Atheism project. Our other registrations can be found on the OSF here [ADD LINK], with copies on our FigShare, and on my GitHub.

This registration is for the testing of the effects of Thinking/Cognitive Styles and Non-Verbal Reasoning on atheism/non-belief. Both cognitive ability and an analytic cognitive style have been argued to be predictors of non-belief or atheism, however mixed evidence exists for both. We will use a non-verbal reasoning task, often used as a measure of cognitive ability, to conduct a large scale cross-cultural examination of the effect of non-verbal reasoning on levels of belief. Similarly we will use an established thinking styles measures to test its effect on belief.

## Hypotheses

Greater analytic thinking scores will predict lower levels of belief.

Greater scores on non-verbal reasoning will predict lower levels of belief.

# Design Plan

## Study type

**Observational Study**. Data is collected from study subjects that are not randomly assigned to a treatment. This includes surveys, natural experiments, and regression discontinuity designs.

## Study design

This registration is for the analysis of data collected as part of our first pilot which is comprised of 5 separate surveys, one for each of the explanatory variable clusters noted in the exploratory pre-registration (see here: ). This specific registration concerns our “Thinking styles” explanatory variables, and is run in the in the UK and Brazil..

## Randomization

The order of the items within both the Non-Verbal Reasoning and the Cognitive Styles questionnaires were randomised. Both the General Belief and Supernatural Belief questionnaires were also randomised within questionnaire.

# Sampling Plan

We will collect representative samples for each nation. This will be done by an independent survey company, and the samples will be representative for the national population by Age, Sex and Geographic Region.

## Existing data

**Registration prior to accessing the data**. As of the date of submission, the data exist, but have not been accessed by you or your collaborators. Commonly, this includes data that has been collected by another researcher or institution.

At the time of registration the data is being collected by the survey company on our teams behalf. No member of our research team has seen any of the data, nor any summary statistics.

## Data collection procedures

Participants are recruited by the independent survey company, Savanta Comres, from their pool of participants. Participants will be paid a local rate for their participation, and will be selected to meet representativeness requirements outlined above.

## Sample size

The sample size is 500 participants per nation.

Brazil = 500

UK = 500

## Sample size rationale

Samples are the maximally viable sample for the financial means of the project.

# Variables

## Measured variables

The explanatory variables of primary interest, Non-Verbal Reasoning and Cognitive Style are part of a survey with the following explanatory variables. See attached variables document for definitions:

* Non-Verbal Reasoning
* Cognitve Style (correct)

Similarly the outcome variables of interest are part of a wide range of response variables that are collected, see the attached codebook for all other variables. The outcome variables by which we will test our hypotheses are as follows. Again, see attached variables document for detailed defintions:

* Belief in God (continuous)
* Belief in God (binary)
* Religious Identification

Details of what comprises each of these measures and scales can be found in the attached codebook.

## Indices

See attached codebook.

# Analysis Plan

We will run confirmatory analyses for each of our response variables noted above, for both of the two explanatory variables. We will also run a number of exploratory analyses outlined in the “Exploratory Analyses” section below. The confirmatory analyses are as follows:

*Confirmatory Analyses*

| Analysis | Explanatory Variables | Outcome Variable |
| --- | --- | --- |
| Cognitive Style 1 | Cognitive Style (correct) | Belief in God (Continuous) |
| Cognitive Style 2 | Cognitive Style (correct) | Belief in God (Binary) |
| Cognitive Style 3 | Cognitive Style (correct) | Religious Identification |
| Non-Verbal Reasoning | Non-Verbal Reasoning | Belief in God (Continuous) |
| Non-Verbal Reasoning | Non-Verbal Reasoning | Belief in God (Binary) |
| Non-Verbal Reasoning | Non-Verbal Reasoning | Religious Identification |

## Statistical models

Bayesian Regression Models will be used to make inferences in the first instance.

Model specifications can be found in the attached Excel file.

We will treat outcome variables that are single Likert scale measures as ordinal, and as such will use cumulative probit regression following the following structure:

library("brms")  
  
exampleProbitModel <-  
 brm(formula = outcome\_variable ~ explanatory\_variable\_1 +  
 explanatory\_variable\_2 +  
 explanatory\_variable\_n,  
 prior = priors,  
 data = data,   
 family = cumulative(link = "probit"),  
 chains = 4,  
 cores = 4,  
 threads = 2,  
 iter = 3000,  
 warmup = 1000,  
 seed = 2023,   
 backend = "cmdstanr")

For binary outcomes we will use logistic regression with the following format:

library("brms")  
  
exampleLogisticModel<-   
 brm(formula = outcome\_variable ~ explanatory\_variable\_1 +  
 explanatory\_variable\_2 +  
 explanatory\_variable\_n,  
 prior = priors,  
 data = data,   
 family = bernoulli(link = "logit"),  
 chains = 4,  
 cores = 4,  
 threads = 2,  
 iter = 3000,  
 warmup = 1000,  
 seed = 2023,   
 backend = "cmdstanr")

And for continuous outcomes we will use gaussian multiple regression:

library("brms")  
  
exampleLogisticModel<-   
 brm(formula = outcome\_variable ~ explanatory\_variable\_1 +  
 explanatory\_variable\_2 +  
 explanatory\_variable\_n,  
 prior = priors,  
 data = data,   
 family = gaussian(),  
 chains = 4,  
 cores = 4,  
 threads = 2,  
 iter = 3000,  
 warmup = 1000,  
 seed = 2023,   
 backend = "cmdstanr")

We will set the following uninformative priors for our outcome variables:

For betas and intercepts we will set a normally distributed prior with a mean of 0 and a standard deviation of 1.

For ordinal probit models we will set a normal distribution for the thresholds, following [Kurz](https://solomonkurz.netlify.app/blog/2021-12-29-notes-on-the-bayesian-cumulative-probit/).

## Transformations

In some instances response variables are dummy coded binary variables from a categorical response option - see attached codebook for all variable definitions.

As a default we will center likert response scores at the center of the scale, unless the scale has a meaningful interval (e.g. age, n years).

## Inference criteria

In the first instance, inferences about whether a variable has or does not have a theoretically relevant effect will be done based on examination of the posterior distributions of parameter estimates.

More specifically we will examine the extent to which the credible intervals of these posterior distributions overlap with a Region of Practical Equivalence (ROPE), that is, a specified region we consider to be theoretically equivalent to zero. This will be done using the {bayestestR} package (<https://easystats.github.io/bayestestR/articles/region_of_practical_equivalence.html>) in R. For our Gaussian and Cumulative Probit models we will use the default range -0.1 to 0.1 for standardized effect sizes, which equates to a “negligible effect size”, and -0.18 to 0.18 for logistic models.

## Data exclusion

Participants who fail data quality checks are removed and replaced by the survey provider prior to our analysis. In the first instance outliers will not be removed, however sensitivity analysis will be run on any published final models.

## Missing data

The data collection process does not allow missing data.

## Exploratory analyses (optional)

We will run measurement invariance analyses to see to what extent the measures used vary across cultures.

# Other

## Other (Optional)

This work is part of a larger scale project using the same data. See decription for further information.

# References