Pilot data analysis for "Essentially blocked - Can structural factors block an essentialist interpretation of a formal explanation?"

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Contents

Introduction

This project's repository and preregistration can be found online.

Methods

Planned Sample

Planned sample size is 5-year-olds and 6-year-olds recruited from a university preschool and museums

Materials

Procedure

2x2 design * Context - nonstructural context, or structural context * Explanation - control explanation, or formal explanation

Essentialism DVs * Pilot 1 (n=14) - 5 canonical essentialism DVs (like in Muradoglu et al, other studies): stability_past, stability_future, innateness_stop, inductive_potential, innateness_switch. But there's a worry that these items are not specific to essentialism, and a structural conception of gender may at times yield what appears to be an essentialist answer to these DVs. * Pilot 2.1 (n=4, all structural) - testing new set of 4 DVs: fc_expl_group, inductivePoten, normative_indiv, innateness_switch * Pilot 2.2 (n=9) - changes in group vs individual level, fc_expl in order to make it flow better as the first item from the previous narration, normative because we're interested in group level normativity: fc_expl_indiv, inductivePoten, normative_group, innateness_switch * Pilot 2.3 (n=7) - minor changes, fc_expl_indiv now mentions "size of the buckets", inductivePoten is now 4 point response instead of 2 point response: fc_expl_indiv_size, inductivePoten, normative_group, innateness_switch

3/31 email: Nadya thinks normativity shouldn't be part of the essentialism battery, she suggests we analyze separately as exploratory. I kind of agree with her actually - discuss w Ellen

Analysis Plan

Exclusion criteria

Experimentor error, out of age range.

Analysis of interest

ANOVA on essentialism measure with an interaction term for context and explanation.

We predict an interaction between context and explanation, such that in the nonstructural condition, hearing a formal explanation relative to a control explanation increases essentialism, but in the structural condition, hearing a formal explanation relative to a control explanation does not increase or increases essentialism to a lesser extent than in the nonstructural condition. In other words, the formal explanation may be interpreted structurally, and an essentialist reading blocked in the structural condition.

–>

Results

Data preparation

Data preparation as specified in the analysis plan.

```
require("knitr")
```

```
## Loading required package: knitr
```

```
## Warning: package 'knitr' was built under R version 3.5.3
```

```
#### Load relevant libraries and functions
library(tidyverse)
```

```
## -- Attaching packages ---------------------- tidyverse 1.2.1 --
```

```
## v ggplot2 3.1.0       v purrr   0.3.2
## v tibble  2.0.1       v dplyr   0.8.0.1
## v tidyr   0.8.2       v stringr 1.4.0
## v readr   1.3.1       v forcats 0.4.0
```

```
## Warning: package 'purrr' was built under R version 3.5.3
```

```
## -- Conflicts ------------------------- tidyverse_conflicts() --
## x dplyr::filter() masks stats::filter()
## x dplyr::lag()    masks stats::lag()
```

```
library(broom)
library(paramtest) # power analysis
```

```
## Warning: package 'paramtest' was built under R version 3.5.3
```

```
#### Import data for analysis
df.data <- read_csv("../data/FYP_data_pilot_children_2.csv")
```

```
## Parsed with column specification:
## cols(
##   .default = col_character(),
##   subject = col_double(),
##   stim = col_double(),
##   age = col_double(),
##   fc_expl_indiv_size_expl = col_logical()
## )
```

```
## See spec(...) for full column specifications.
```

```
#### Data exclusion / filtering
# Record exclusions: experimentor error, age
df.excl <- tibble(
  exp_error = sum(df.data$exp_error == "yes"),
  age = sum(df.data$age < 5 | df.data$age >= 7)
  )

# Exclude subjects: experimentor error, age
df.data <- df.data %>%
  filter(exp_error == "no" &
           (age >= 5 & age < 7)) %>%
  select(-exp_error, -starts_with("check")) # Delete exp_error, check columns
```

```
#### Memory check analysis
```

```
#### Demographics analysis
# Add age categorical variable
df.data <- df.data %>%
  mutate(age_cat = case_when(
    age < 5 ~ "4",
    age >= 5 & age < 6 ~ "5",
    age >= 6 & age < 7 ~ "6",
    age >= 7 ~ "7"))

# Age
df.dem_age <- df.data %>%
```

```
  count(age_cat)

# Gender
df.dem_gender <- df.data %>%
  count(gender)
```

```
#### Prepare data for analysis

# Recode essentialism dependent measures
df.data$fc_expl_group <- df.data$fc_expl_group %>%
  recode("Because of the buckets in their classrooms" = 0,
         "Because girls like playing Yellow-Ball" = 1,
         "Because girls like playing Green-Ball" = 1)
df.data$fc_expl_indiv <- df.data$fc_expl_indiv %>%
  recode("Because of the buckets in her classroom" = 0,
         "Because Suzy likes playing Yellow-Ball" = 1,
         "Because Suzy likes playing Green-Ball" = 1)
df.data$fc_expl_indiv_size <- df.data$fc_expl_indiv_size %>%
  recode("Because of the size of the buckets in her classroom" = 0,
         "Because Suzy likes playing Yellow-Ball" = 1,
         "Because Suzy likes playing Green-Ball" = 1)

df.data$normative_group <- df.data$normative_group %>%
  recode("Okay" = 0,
         "Not okay" = 1)
df.data$normative_indiv <- df.data$normative_indiv %>%
  recode("Okay" = 0,
         "Not okay" = 1)

df.data$inductivePoten <-
  if_else(df.data$cb == "girlsYellow",
          (recode(df.data$inductivePoten,
                  "Green-Ball" = 1/6,
                  "Yellow-Ball" = 5/6, # conservatively estimate as midway between maybe and for sure
                  "For sure Green-Ball" = 0,
                  "Maybe Green-Ball" = 1/3,
                  "Maybe Yellow-Ball" = 2/3,
                  "For sure Yellow-Ball" = 1)),
          (recode(df.data$inductivePoten,
                  "Yellow-Ball" = 1/6,
                  "Green-Ball" = 5/6,
                  "For sure Yellow-Ball" = 0,
                  "Maybe Yellow-Ball" = 1/3,
                  "Maybe Green-Ball" = 2/3,
                  "For sure Green-Ball" = 1)))

df.data$innateness_switch <-
  if_else(df.data$cb == "girlsYellow",
          (recode(df.data$innateness_switch,
                  "For sure Green-Ball" = 0,
                  "Maybe Green-Ball" = 1/3,
                  "Maybe Yellow-Ball" = 2/3,
                  "For sure Yellow-Ball" = 1)),
```

```
          (recode(df.data$innateness_switch,
                  "For sure Green-Ball" = 1,
                  "Maybe Green-Ball" = 2/3,
                  "Maybe Yellow-Ball" = 1/3,
                  "For sure Yellow-Ball" = 0)))


# Gather to tidy long form
df.tidy <- df.data %>%
  select(-starts_with("check"), -ends_with("expl")) %>%
  gather(question, response, "fc_expl_indiv":"innateness_switch")


# Order questions
df.tidy$question <-  df.tidy$question %>%
  factor(levels=c('fc_expl_indiv_size', 'fc_expl_indiv', 'fc_expl_group', 'normative_indiv', 'normative_


# Split dataset by DV set
df.tidy.1 <- df.tidy %>%
  filter(dvs == "fc_expl_group, inductivePoten, normative_indiv, innateness_switch")
df.tidy.2 <- df.tidy %>%
  filter(dvs == "fc_expl_indiv, inductivePoten, normative_group, innateness_switch")
df.tidy.3 <- df.tidy %>%
  filter(dvs == "fc_expl_indiv_size, inductivePoten, normative_group, innateness_switch")
df.tidy.2.3 <- df.tidy %>%
  filter(dvs == "fc_expl_indiv, inductivePoten, normative_group, innateness_switch" | dvs == "fc_expl_in

# Calculate overall essentialism measure per subject
df.means_subj <- df.tidy %>%
  group_by(subject, age, context, explanation, dvs) %>%
  summarize(essentialism = mean(response, na.rm = TRUE))
df.means_subj.1 <- df.tidy.1 %>%
  group_by(subject, age, context, explanation, dvs) %>%
  summarize(essentialism = mean(response, na.rm = TRUE))
df.means_subj.2 <- df.tidy.2 %>%
  group_by(subject, age, context, explanation, dvs) %>%
  summarize(essentialism = mean(response, na.rm = TRUE))
df.means_subj.3 <- df.tidy.3 %>%
  group_by(subject, age, context, explanation, dvs) %>%
  summarize(essentialism = mean(response, na.rm = TRUE))
df.means_subj.2.3 <- df.tidy.2.3 %>%
  group_by(subject, age, context, explanation, dvs) %>%
  summarize(essentialism = mean(response, na.rm = TRUE))

df.means_subj.2.3.noNormative <- df.tidy.2.3 %>%
  filter(!str_detect(question, "normative")) %>%
  group_by(subject, age, context, explanation, dvs) %>%
  summarize(essentialism = mean(response, na.rm = TRUE))
```

Exploring the pilot 2 data

```
# Overall essentialism measure across subjects by condition
df.means <- df.tidy %>%
  group_by(context, explanation) %>%
  summarize(essentialism = mean(response, na.rm = TRUE),
            sd = sd(response, na.rm = TRUE),
            n = length(unique(subject)))
df.means
```

```
## # A tibble: 4 x 5
## # Groups:   context [2]
##   context       explanation essentialism    sd     n
##   <chr>         <chr>              <dbl> <dbl> <int>
## 1 nonstructural control            0.354 0.389     4
## 2 nonstructural formal             0.5   0.467     4
## 3 structural    control            0.354 0.412     6
## 4 structural    formal             0.361 0.398     6
```

```
df.means.1 <- df.tidy.1 %>%
  group_by(context, explanation) %>%
  summarize(essentialism = mean(response, na.rm = TRUE),
            sd = sd(response, na.rm = TRUE),
            n = length(unique(subject)))
df.means.1
```

```
## # A tibble: 2 x 5
## # Groups:   context [1]
##   context    explanation essentialism    sd     n
##   <chr>      <chr>              <dbl> <dbl> <int>
## 1 structural control            0.417 0.454     2
## 2 structural formal             0.375 0.478     2
```

```
df.means.2 <- df.tidy.2 %>%
  group_by(context, explanation) %>%
  summarize(essentialism = mean(response, na.rm = TRUE),
            sd = sd(response, na.rm = TRUE),
            n = length(unique(subject)))
df.means.2
```

```
## # A tibble: 4 x 5
## # Groups:   context [2]
##   context       explanation essentialism    sd     n
##   <chr>         <chr>              <dbl> <dbl> <int>
## 1 nonstructural control            0.5   0.427     2
## 2 nonstructural formal             0.333 0.427     2
## 3 structural    control            0.292 0.384     3
## 4 structural    formal             0.333 0.388     2
```

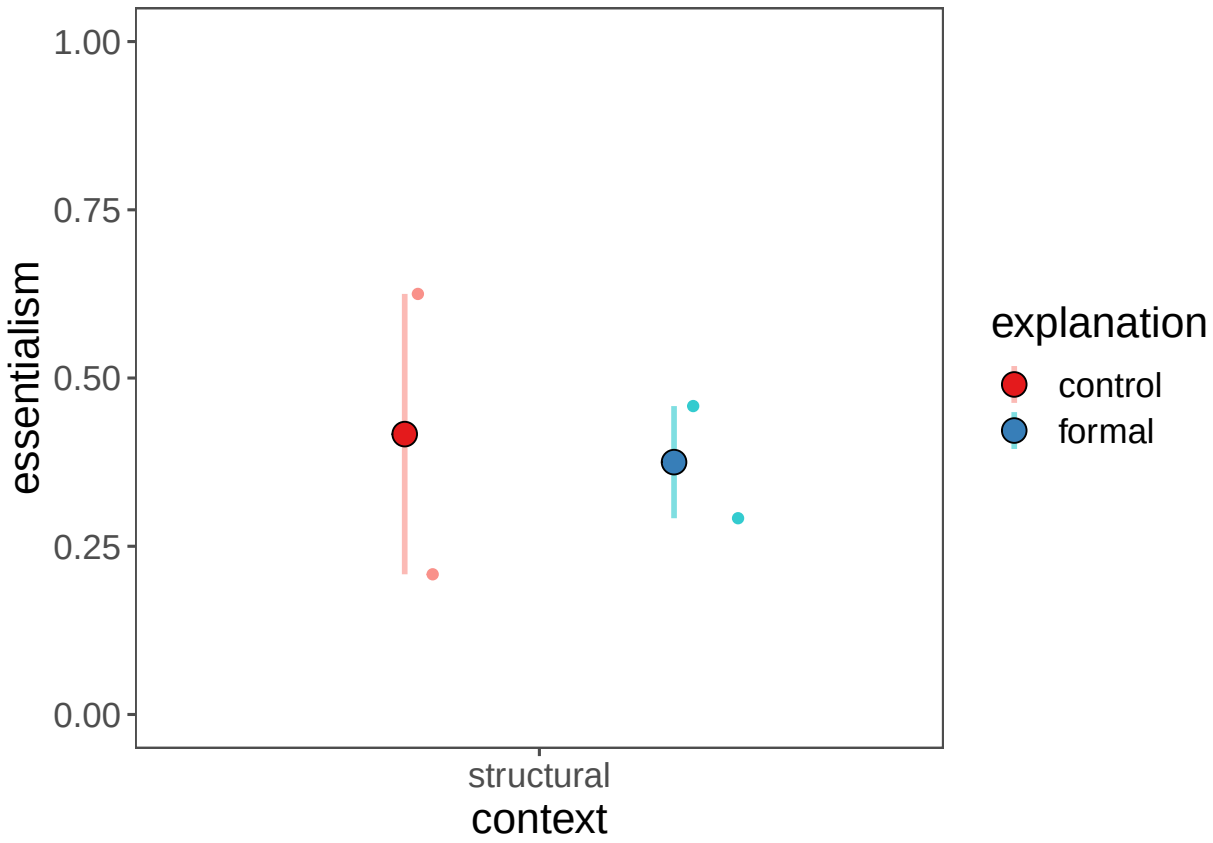
```
df.means.3 <- df.tidy.3 %>%
  group_by(context, explanation) %>%
```

```
  summarize(essentialism = mean(response, na.rm = TRUE),
            sd = sd(response, na.rm = TRUE),
            n = length(unique(subject)))
df.means.3
```

```
## # A tibble: 4 x 5
## # Groups:   context [2]
##   context       explanation essentialism    sd     n
##   <chr>         <chr>              <dbl> <dbl> <int>
## 1 nonstructural control            0.208 0.305     2
## 2 nonstructural formal             0.667 0.471     2
## 3 structural    control            0.417 0.5       1
## 4 structural    formal             0.375 0.375     2
```

```
# Set visualization theme
theme_set(
  ggthemes::theme_few() +
  theme(text = element_text(size = 16)) # large text size for presentation figures
)
```

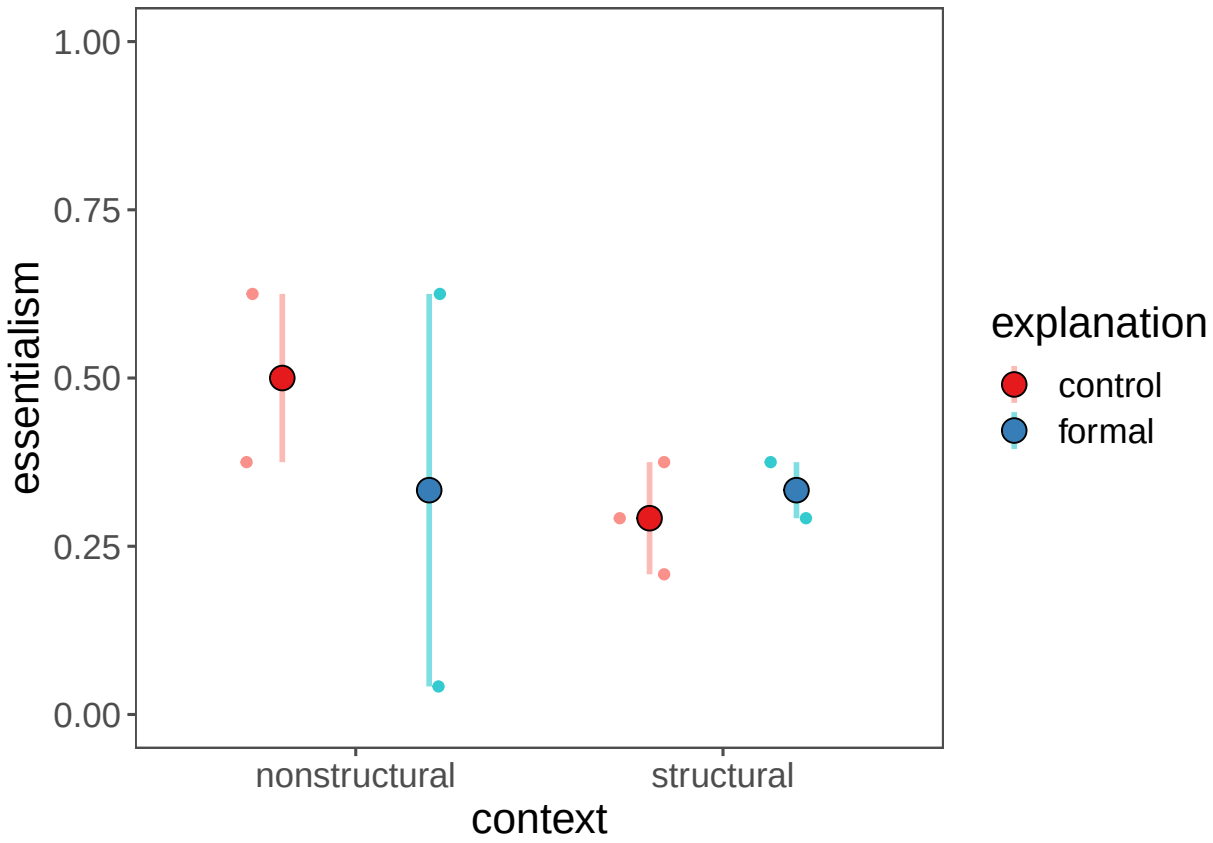
```
# Pilot 2.1: essentialism by context and explanation
ggplot(df.means_subj.1, aes(x = context, y = essentialism, fill = explanation, color = explanation)) +
  geom_point(position = position_jitterdodge(jitter.width = 0.2, dodge.width = 0.8),
             alpha = 0.8) +
  stat_summary(fun.data = "mean_cl_boot",
               position = position_dodge(width = 0.8),
               geom = "linerange",
               size = 1,
               alpha = 0.5) +
  stat_summary(fun.y = "mean",
               position = position_dodge(width = 0.8),
               geom = "point",
               shape = 21,
               color = "black",
               size = 4) +
  scale_fill_brewer(palette = "Set1") +
  scale_y_continuous(limits = c(0, 1))
```




```
ggsave("FYP_pilot_children_2.1_contextExpl.png", width = 5)
```

```
## Saving 5 x 4.5 in image
```

```
# Pilot 2.2: essentialism by context and explanation
ggplot(df.means_subj.2, aes(x = context, y = essentialism, fill = explanation, color = explanation)) +
  geom_point(position = position_jitterdodge(jitter.width = 0.2, dodge.width = 0.8),
             alpha = 0.8) +
  stat_summary(fun.data = "mean_cl_boot",
               position = position_dodge(width = 0.8),
               geom = "linerange",
               size = 1,
               alpha = 0.5) +
  stat_summary(fun.y = "mean",
               position = position_dodge(width = 0.8),
               geom = "point",
               shape = 21,
               color = "black",
               size = 4) +
  scale_fill_brewer(palette = "Set1") +
  scale_y_continuous(limits = c(0, 1))
```

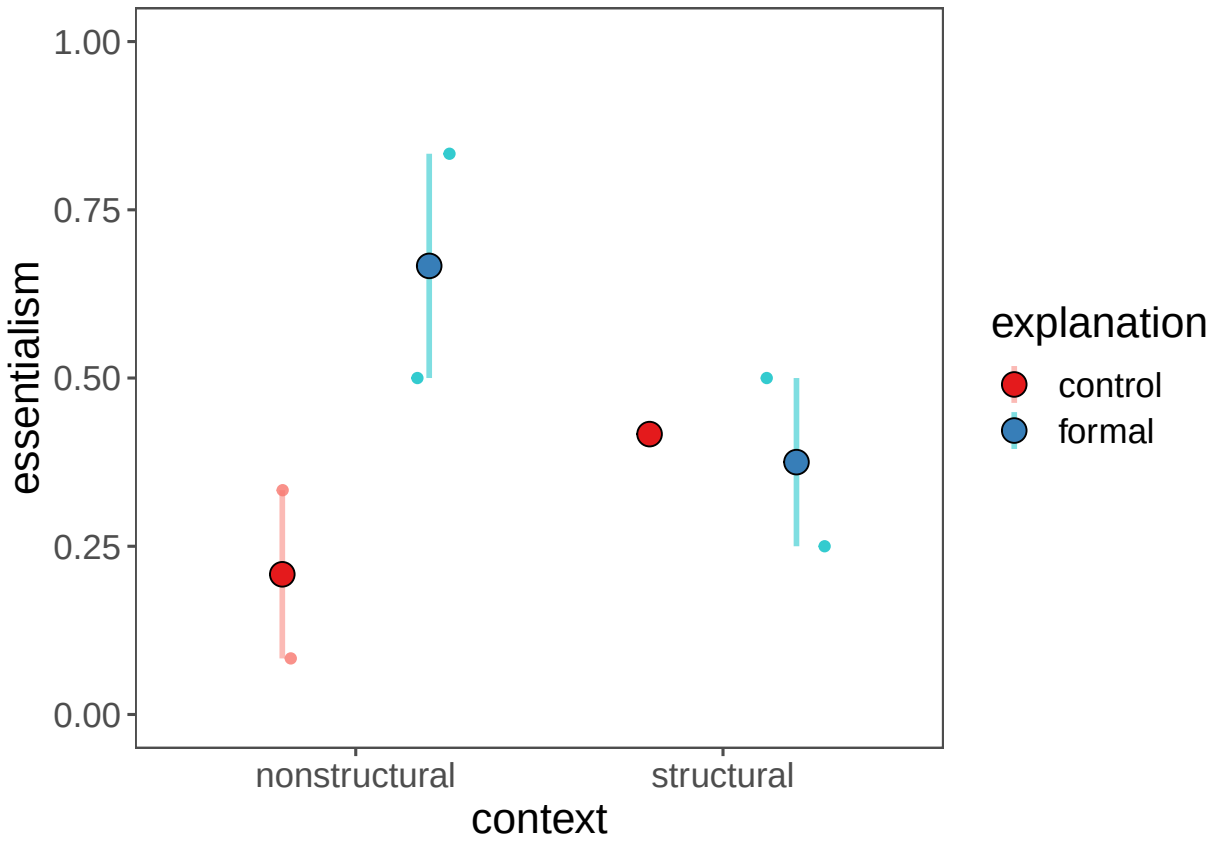



```
ggsave("FYP_pilot_children_2.2_contextExpl.png", width = 5)
```

```
## Saving 5 x 4.5 in image
```

```
# Pilot 2.3: essentialism by context and explanation
ggplot(df.means_subj.3, aes(x = context, y = essentialism, fill = explanation, color = explanation)) +
  geom_point(position = position_jitterdodge(jitter.width = 0.2, dodge.width = 0.8),
             alpha = 0.8) +
  stat_summary(fun.data = "mean_cl_boot",
               position = position_dodge(width = 0.8),
               geom = "linerange",
               size = 1,
               alpha = 0.5) +
  stat_summary(fun.y = "mean",
               position = position_dodge(width = 0.8),
               geom = "point",
               shape = 21,
               color = "black",
               size = 4) +
  scale_fill_brewer(palette = "Set1") +
  scale_y_continuous(limits = c(0, 1))
```

```
## Warning: Removed 1 rows containing missing values (geom_linerange).
```

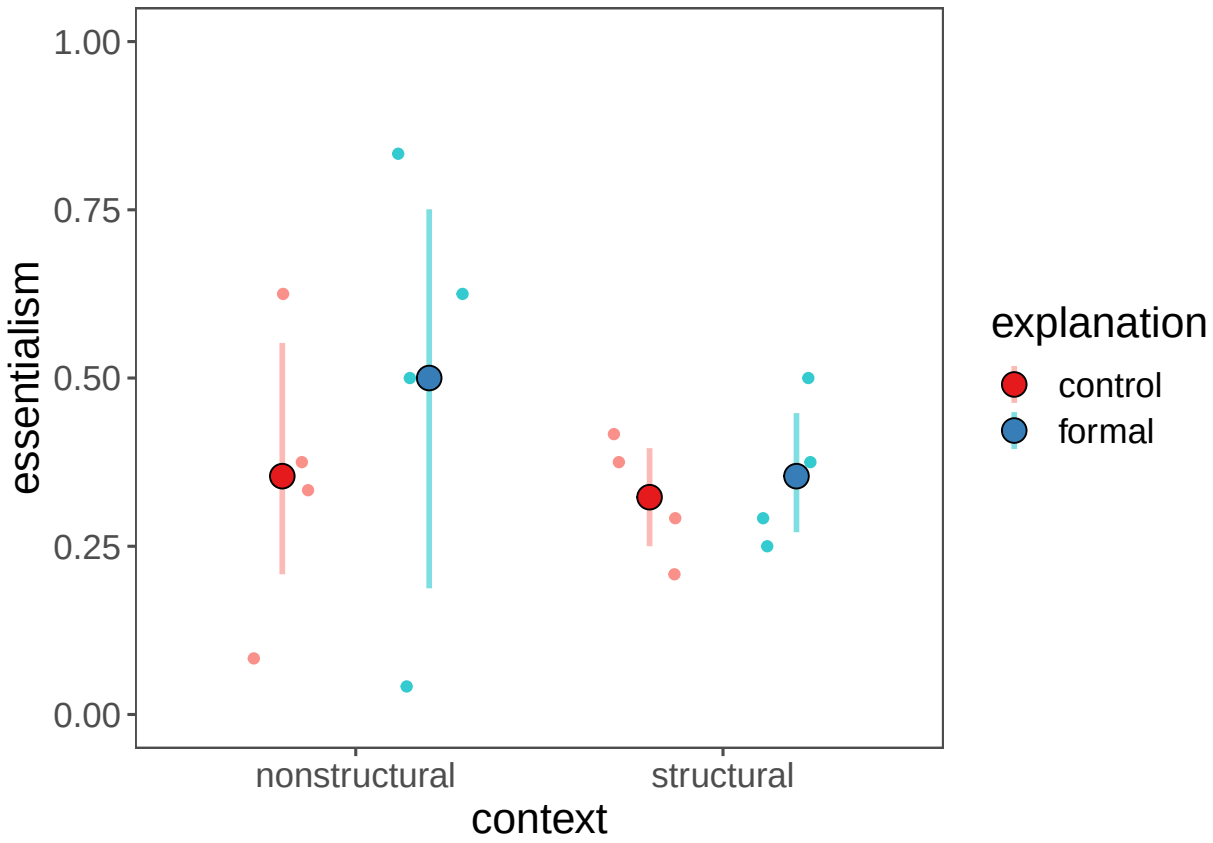



```
ggsave("FYP_pilot_children_2.3_contextExpl.png", width = 5)
```

```
## Saving 5 x 4.5 in image
```

```
## Warning: Removed 1 rows containing missing values (geom_linerange).
```

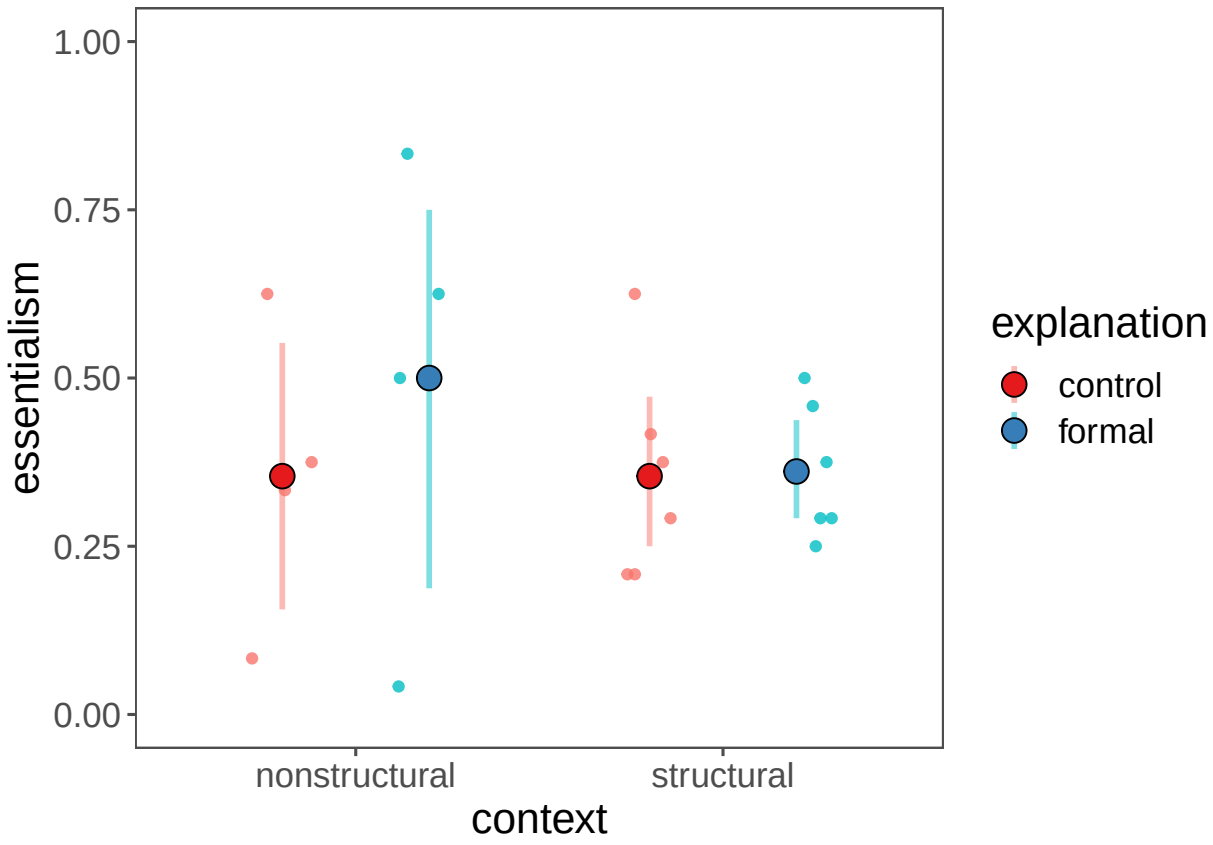
```
# Pilot 2.2 + 2.3: essentialism by context and explanation
ggplot(df.means_subj.2.3, aes(x = context, y = essentialism, fill = explanation, color = explanation)) +
  geom_point(position = position_jitterdodge(jitter.width = 0.2, dodge.width = 0.8),
             alpha = 0.8) +
  stat_summary(fun.data = "mean_cl_boot",
               position = position_dodge(width = 0.8),
               geom = "linerange",
               size = 1,
               alpha = 0.5) +
  stat_summary(fun.y = "mean",
               position = position_dodge(width = 0.8),
               geom = "point",
               shape = 21,
               color = "black",
               size = 4) +
  scale_fill_brewer(palette = "Set1") +
  scale_y_continuous(limits = c(0, 1))
```




```
ggsave("FYP_pilot_children_2.2_2.3_contextExpl.png", width = 5)
```

```
## Saving 5 x 4.5 in image
```

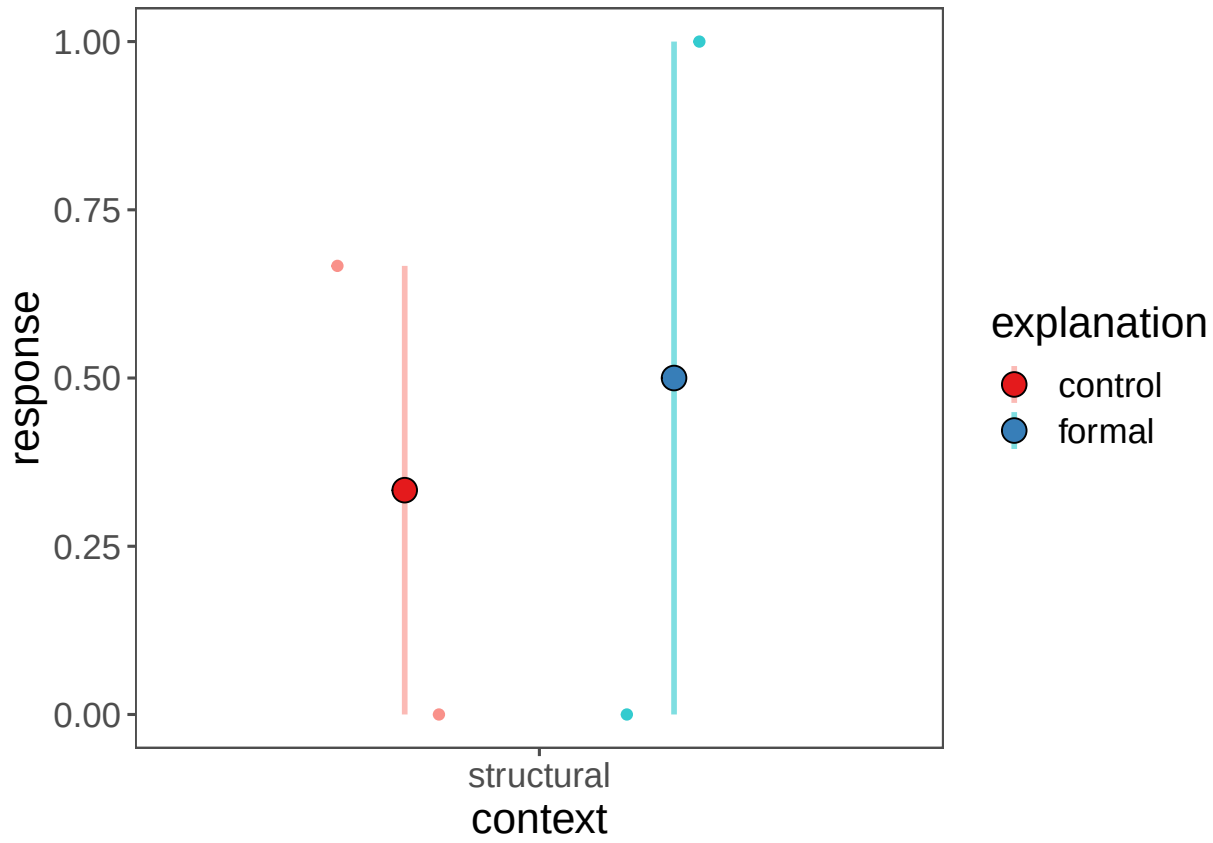
```
# Pilot 2.1 + 2.2 + 2.3: essentialism by context and explanation
ggplot(df.means_subj, aes(x = context, y = essentialism, fill = explanation, color = explanation)) +
  geom_point(position = position_jitterdodge(jitter.width = 0.2, dodge.width = 0.8),
             alpha = 0.8) +
  stat_summary(fun.data = "mean_cl_boot",
               position = position_dodge(width = 0.8),
               geom = "linerange",
               size = 1,
               alpha = 0.5) +
  stat_summary(fun.y = "mean",
               position = position_dodge(width = 0.8),
               geom = "point",
               shape = 21,
               color = "black",
               size = 4) +
  scale_fill_brewer(palette = "Set1") +
  scale_y_continuous(limits = c(0, 1))
```




```
ggsave("FYP_pilot_children_2.1_2.2_2.3_contextExpl.png", width = 5)
```

```
## Saving 5 x 4.5 in image
```

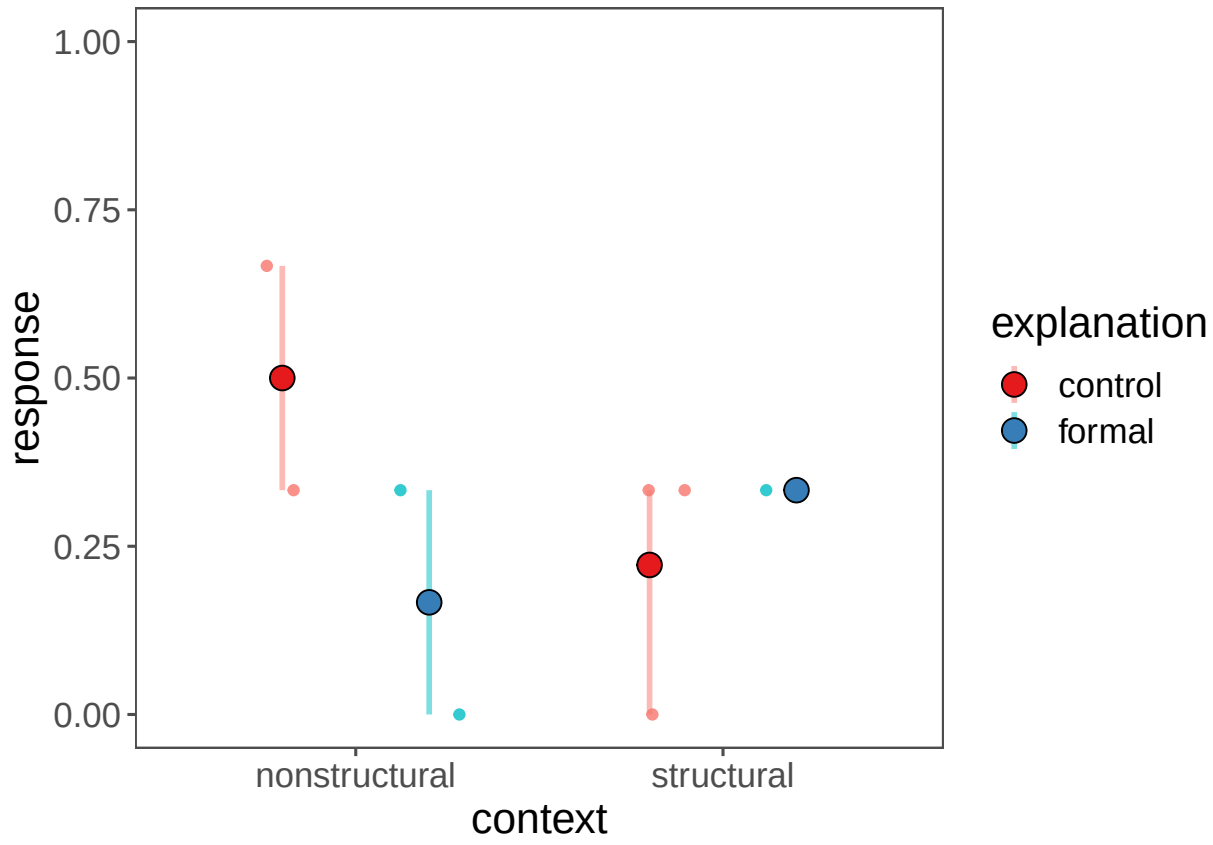
```
# Pilot 2.1 (innateness switch only): essentialism by context and explanation
ggplot(df.tidy.1 %>% filter(question == "innateness_switch"), aes(x = context, y = response, fill = expl
  geom_point(position = position_jitterdodge(jitter.width = 0.2, dodge.width = 0.8),
             alpha = 0.8) +
  stat_summary(fun.data = "mean_cl_boot",
               position = position_dodge(width = 0.8),
               geom = "linerange",
               size = 1,
               alpha = 0.5) +
  stat_summary(fun.y = "mean",
               position = position_dodge(width = 0.8),
               geom = "point",
               shape = 21,
               color = "black",
               size = 4) +
  scale_fill_brewer(palette = "Set1") +
  scale_y_continuous(limits = c(0, 1))
```




```
ggsave("FYP_pilot_children_2.1_contextExpl_innatenessSwitch.png", width = 5)
```

```
## Saving 5 x 4.5 in image
```

```
# Pilot 2.2 (innateness switch only): essentialism by context and explanation
ggplot(df.tidy.2 %>% filter(question == "innateness_switch"), aes(x = context, y = response, fill = expl
  geom_point(position = position_jitterdodge(jitter.width = 0.2, dodge.width = 0.8),
             alpha = 0.8) +
  stat_summary(fun.data = "mean_cl_boot",
               position = position_dodge(width = 0.8),
               geom = "linerange",
               size = 1,
               alpha = 0.5) +
  stat_summary(fun.y = "mean",
               position = position_dodge(width = 0.8),
               geom = "point",
               shape = 21,
               color = "black",
               size = 4) +
  scale_fill_brewer(palette = "Set1") +
  scale_y_continuous(limits = c(0, 1))
```

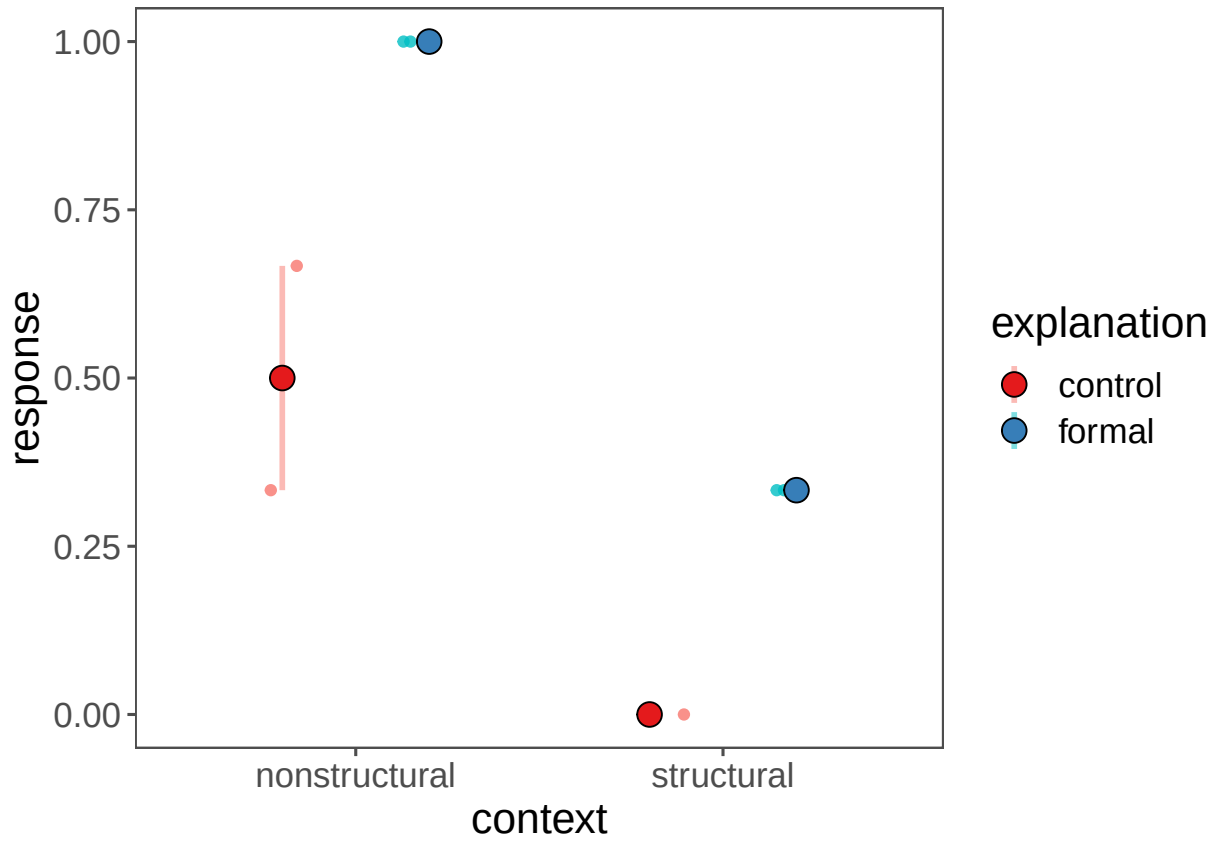



```
ggsave("FYP_pilot_children_2.2_contextExpl_innatenessSwitch.png", width = 5)
```

```
## Saving 5 x 4.5 in image
```

```
# Pilot 2.3 (innateness switch only): essentialism by context and explanation
ggplot(df.tidy.3 %>% filter(question == "innateness_switch"), aes(x = context, y = response, fill = expl
  geom_point(position = position_jitterdodge(jitter.width = 0.2, dodge.width = 0.8),
             alpha = 0.8) +
  stat_summary(fun.data = "mean_cl_boot",
               position = position_dodge(width = 0.8),
               geom = "linerange",
               size = 1,
               alpha = 0.5) +
  stat_summary(fun.y = "mean",
               position = position_dodge(width = 0.8),
               geom = "point",
               shape = 21,
               color = "black",
               size = 4) +
  scale_fill_brewer(palette = "Set1") +
  scale_y_continuous(limits = c(0, 1))
```

```
## Warning: Removed 1 rows containing missing values (geom_linerange).
```

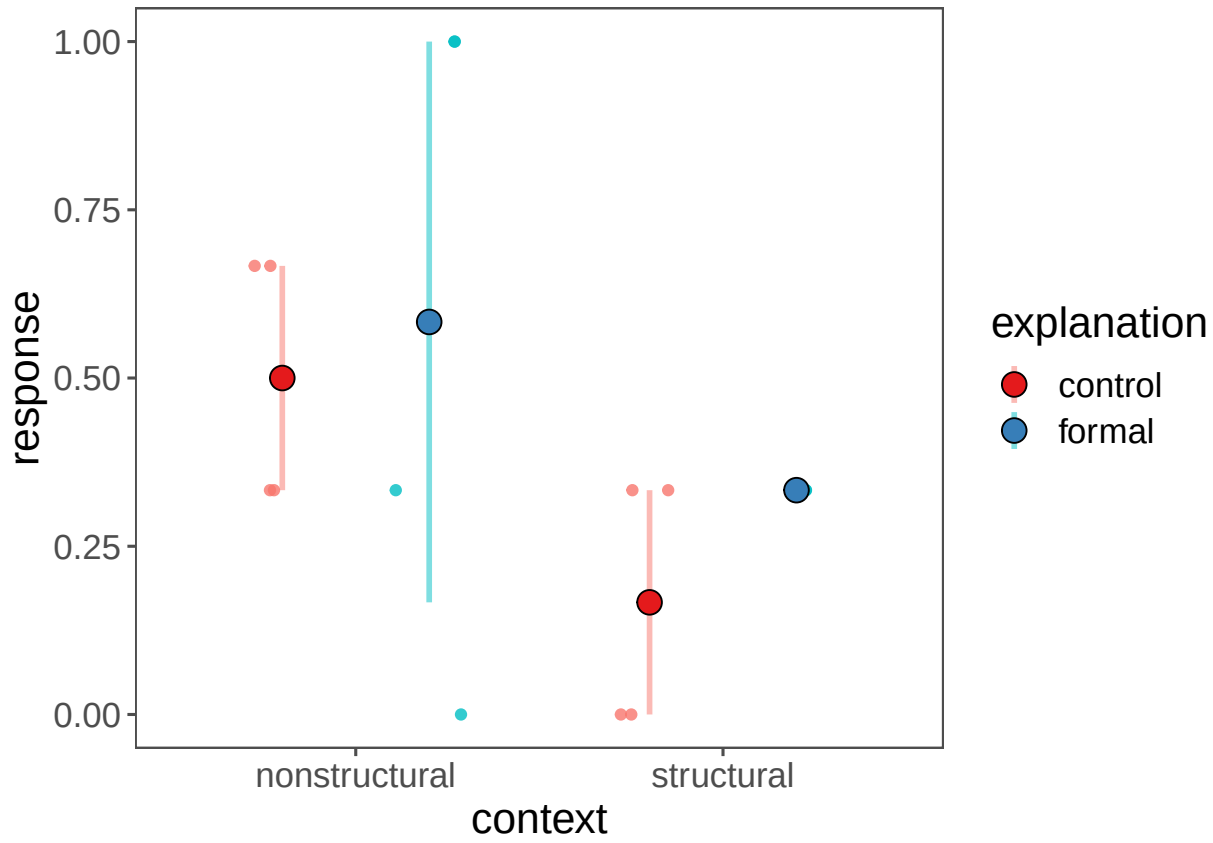



```
ggsave("FYP_pilot_children_2.3_contextExpl_innatenessSwitch.png", width = 5)
```

```
## Saving 5 x 4.5 in image
```

```
## Warning: Removed 1 rows containing missing values (geom_linerange).
```

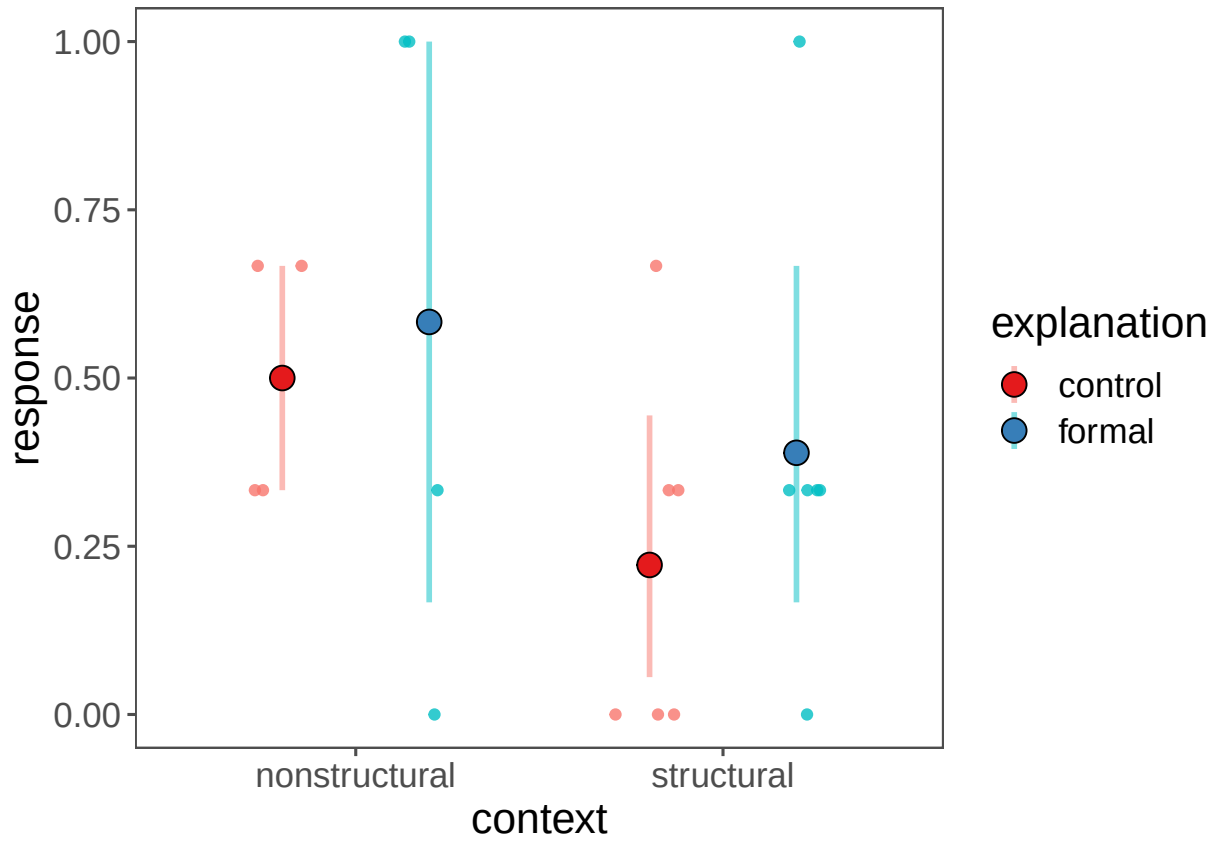
```
# Pilot 2.2 + 2.3 (innateness switch only): essentialism by context and explanation
ggplot(df.tidy.2.3 %>% filter(question == "innateness_switch"), aes(x = context, y = response, fill = ex
  geom_point(position = position_jitterdodge(jitter.width = 0.2, dodge.width = 0.8),
             alpha = 0.8) +
  stat_summary(fun.data = "mean_cl_boot",
               position = position_dodge(width = 0.8),
               geom = "linerange",
               size = 1,
               alpha = 0.5) +
  stat_summary(fun.y = "mean",
               position = position_dodge(width = 0.8),
               geom = "point",
               shape = 21,
               color = "black",
               size = 4) +
  scale_fill_brewer(palette = "Set1") +
  scale_y_continuous(limits = c(0, 1))
```




```
ggsave("FYP_pilot_children_2.2_2.3_contextExpl_innatenessSwitch.png", width = 5)
```

```
## Saving 5 x 4.5 in image
```

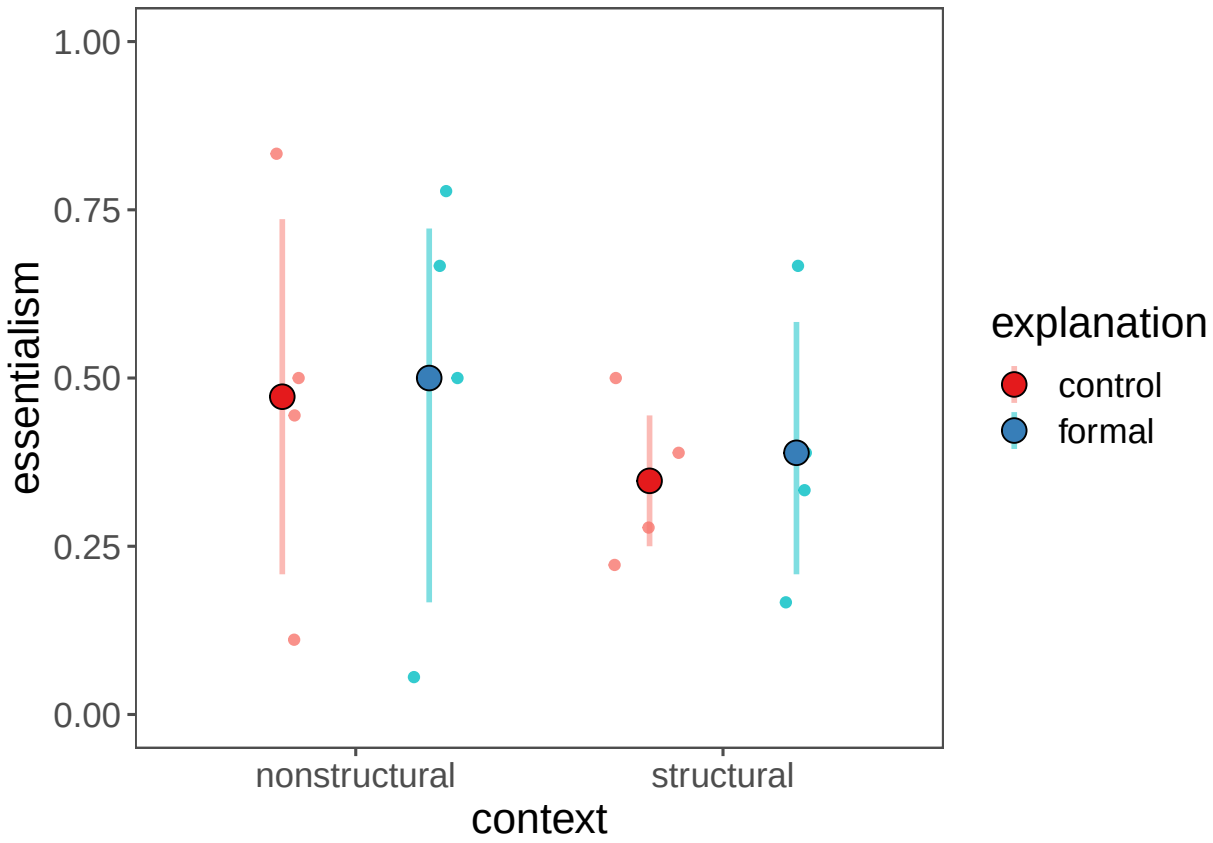
```
# Pilot 2.1 + 2.2 + 2.3 (innateness switch only): essentialism by context and explanation
ggplot(df.tidy %>% filter(question == "innateness_switch"), aes(x = context, y = response, fill = explan
  geom_point(position = position_jitterdodge(jitter.width = 0.2, dodge.width = 0.8),
             alpha = 0.8) +
  stat_summary(fun.data = "mean_cl_boot",
               position = position_dodge(width = 0.8),
               geom = "linerange",
               size = 1,
               alpha = 0.5) +
  stat_summary(fun.y = "mean",
               position = position_dodge(width = 0.8),
               geom = "point",
               shape = 21,
               color = "black",
               size = 4) +
  scale_fill_brewer(palette = "Set1") +
  scale_y_continuous(limits = c(0, 1))
```




```
ggsave("FYP_pilot_children_2.1_2.2_2.3_contextExpl_innatenessSwitch.png", width = 5)
```

```
## Saving 5 x 4.5 in image
```

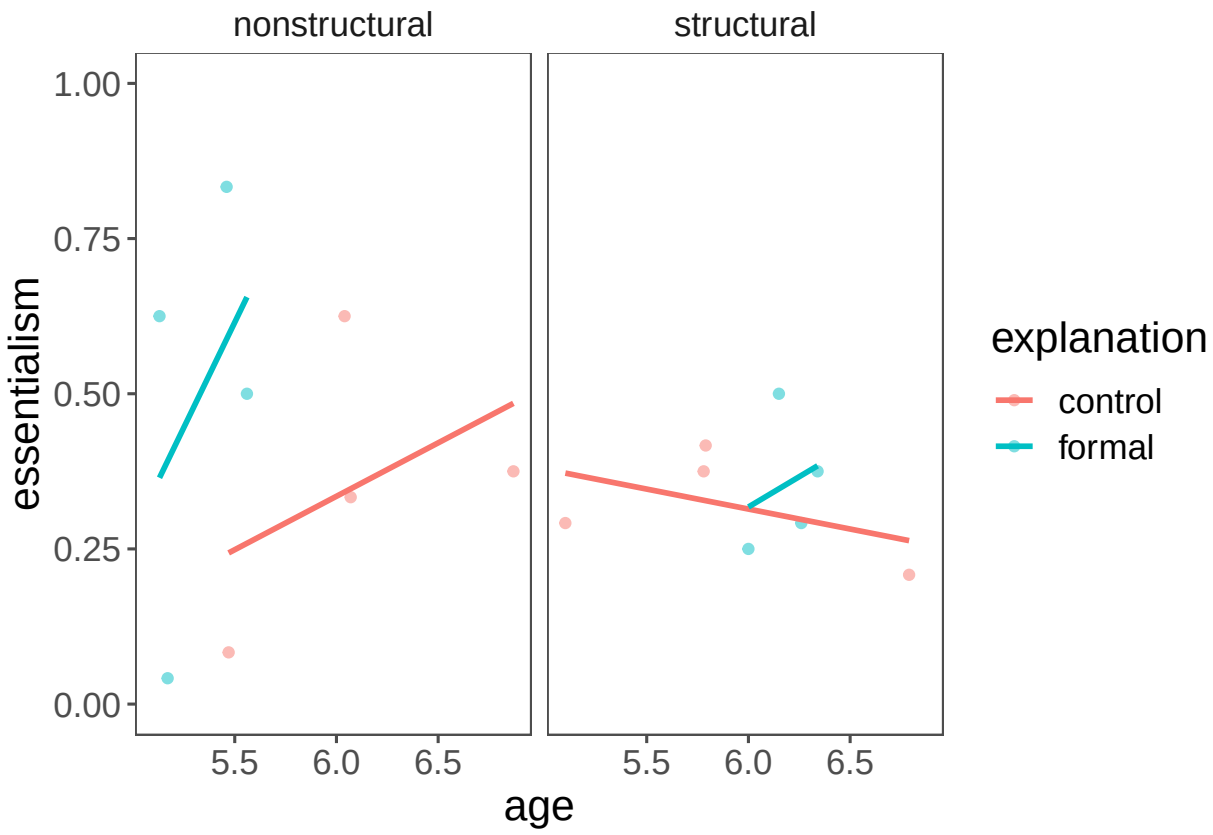
```
# Pilot 2.2 + 2.3 (no normative): essentialism by context and explanation
ggplot(df.means_subj.2.3.noNormative, aes(x = context, y = essentialism, fill = explanation, color = ex
  geom_point(position = position_jitterdodge(jitter.width = 0.2, dodge.width = 0.8),
             alpha = 0.8) +
  stat_summary(fun.data = "mean_cl_boot",
               position = position_dodge(width = 0.8),
               geom = "linerange",
               size = 1,
               alpha = 0.5) +
  stat_summary(fun.y = "mean",
               position = position_dodge(width = 0.8),
               geom = "point",
               shape = 21,
               color = "black",
               size = 4) +
  scale_fill_brewer(palette = "Set1") +
  scale_y_continuous(limits = c(0, 1))
```




```
ggsave("FYP_pilot_children_2.2_2.3_contextExpl_noNormative.png", width = 5)
```

```
## Saving 5 x 4.5 in image
```

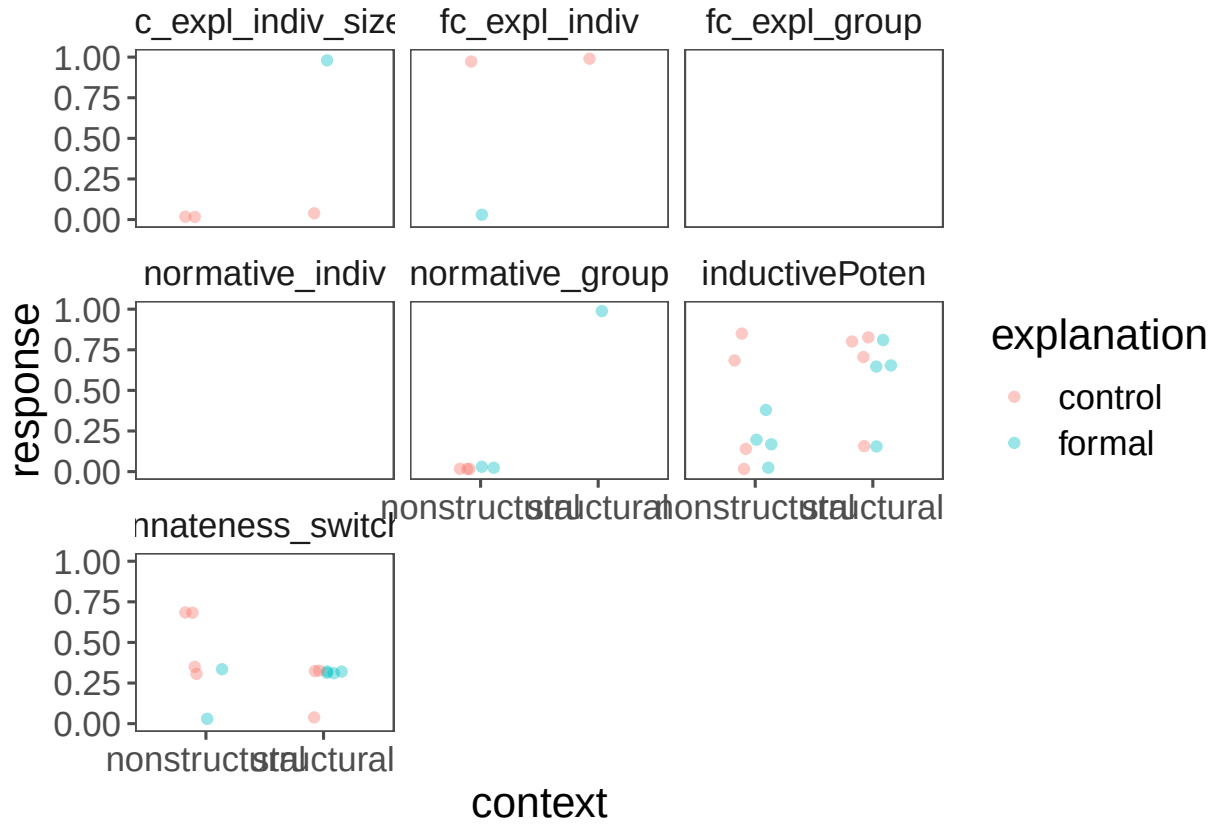
```
# Essentialism by explanation over age, faceted by context
ggplot(df.means_subj.2.3, aes(x = age, y = essentialism, fill = explanation, color = explanation)) +
  facet_wrap(~ context) +
  geom_point(alpha = 0.5) +
  geom_smooth(method = "lm", se = FALSE) +
  scale_fill_brewer(palette = "Set1") +
  scale_y_continuous(limits = c(0, 1))
```




```
# Essentialism by context and explanation, faceted by DV
ggplot(df.tidy.2.3, aes(x = context, y = response, fill = explanation, color = explanation)) +
  facet_wrap(~ question) +
  geom_point(alpha = 0.4,
             position = position_jitterdodge(jitter.width = 0.2, jitter.height = 0.05, dodge.width = 0.4
  scale_fill_brewer(palette = "Set1") +
  scale_y_continuous(limits = c(0, 1))
```

```
## Warning in min(x): no non-missing arguments to min; returning Inf

## Warning in max(x): no non-missing arguments to max; returning -Inf

## Warning in min(x): no non-missing arguments to min; returning Inf

## Warning in max(x): no non-missing arguments to max; returning -Inf

## Warning in min(x): no non-missing arguments to min; returning Inf

## Warning in max(x): no non-missing arguments to max; returning -Inf

## Warning in min(x): no non-missing arguments to min; returning Inf

## Warning in max(x): no non-missing arguments to max; returning -Inf
```

```
## Warning: Removed 70 rows containing missing values (geom_point).
```




```
ggsave("FYP_pilot_children_2_contextExpl_DV.png")
```

```
## Saving 6.5 x 4.5 in image
## Warning in min(x): no non-missing arguments to min; returning Inf
## Warning in max(x): no non-missing arguments to max; returning -Inf
## Warning in min(x): no non-missing arguments to min; returning Inf
## Warning in max(x): no non-missing arguments to max; returning -Inf
## Warning in min(x): no non-missing arguments to min; returning Inf
## Warning in max(x): no non-missing arguments to max; returning -Inf
## Warning in min(x): no non-missing arguments to min; returning Inf
## Warning in max(x): no non-missing arguments to max; returning -Inf
## Warning: Removed 70 rows containing missing values (geom_point).
```

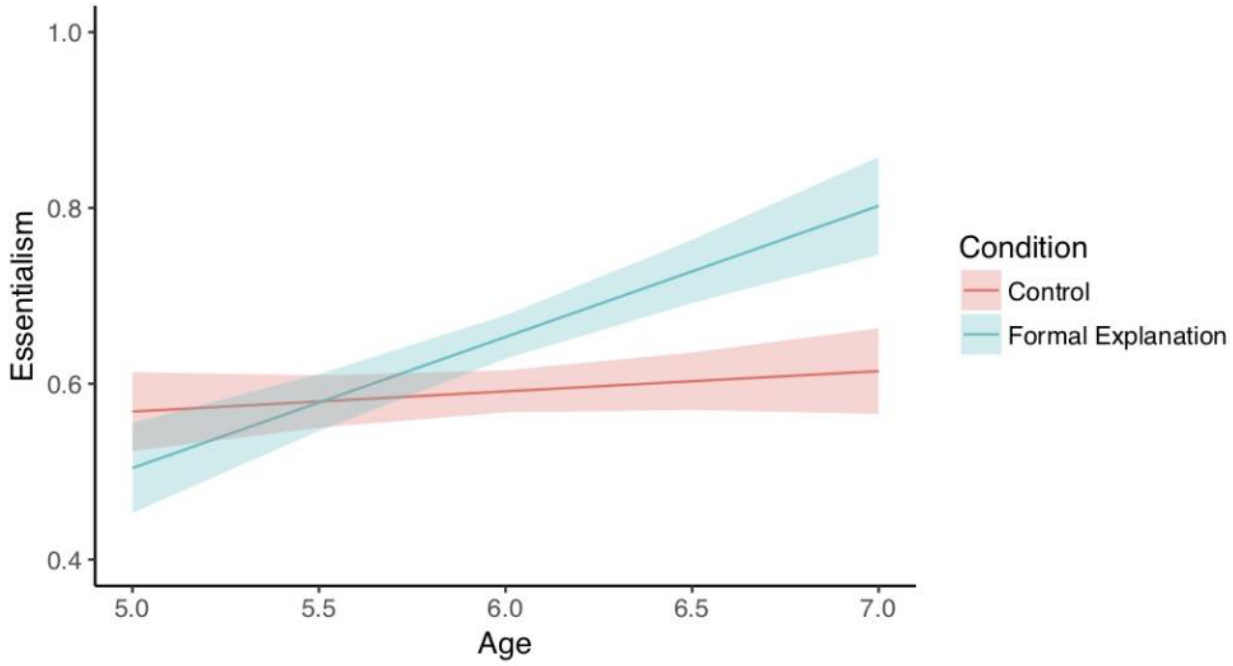


Figure 1: Muradoglu et al 2019 Exp 2 explanation on essentialism results

Target analysis

The analyses as specified in the analysis plan.

```
# contextExpl.2.3 <- df.means_subj.2.3 %>%
#   aov(essentialism ~ 1 + context * explanation, .) %>%
#   tidy()
```

Power Analysis

Power Analysis based on prior studies

Nadya's estimate is 30 to 50 per cell, so n = 120 to `50*4` total.

Muradoglu et al 2019 (Exp 2 on gender) ran 93 5-6yo in either a formal explanation or control explanation condition (both basically nonstructural), and measured essentialism using 5 essentialism DVs (coded as 0 to 1, with greater being more essentialist).

> Although the main effect of condition was not significant, p = .11, the condition by age interaction was, p = .044. Six-year-olds, but not 5-year olds, showed higher essentialism for properties introduced via formal explanations (ps = .011 and .999, respectively; see Figure 2). Children also gave more essentialist responses with age, p = .003.

Vasilyeva et al 2018 ran 48 5-6yo (also some 4-5 and adults) in either a structural context or nonstructural context (both basically without giving an explanation), and measured essentialism using 1 essentialism DV (innateness_switch, which they call mutability, coded as 1, 2, 3, 4, with greater being less essentialist).

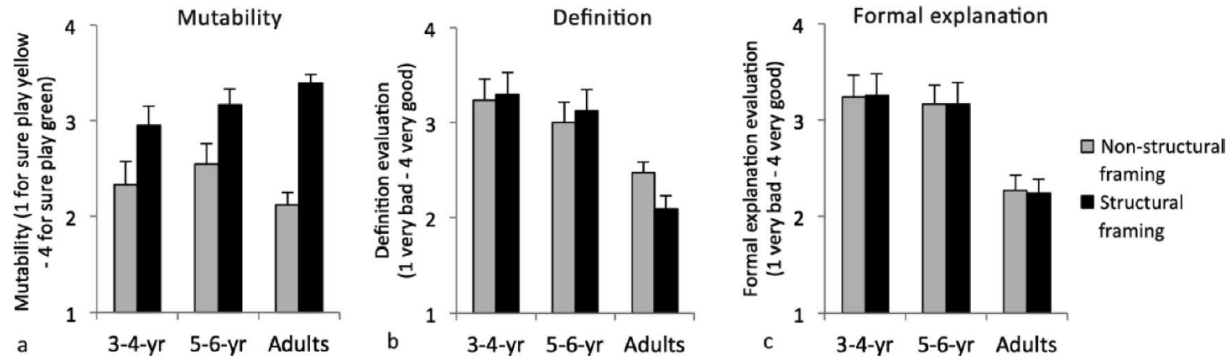


Figure 4. Mutability (a), partial definition (b), and formal explanation ratings (c) as a function of framing condition and age group. Error bars represent 1 *SEM*.

Figure 2: Vasilyeva et al 2019 context on mutability results

an ANOVA with framing condition and age group as between-subjects factors revealed the predicted main effect of framing, F(1, 85) = 8.95, p = .004, partial_eta_p_sq = .095, with no main effect of age group, F(1, 85) = 1.05, p = .309, nor interaction, F(1, 85) = .01, p = .984. Similarly, adults rated the target property as more mutable under the structural than nonstructural framing, t(65) = 8.04, p = .001, d = 2.00.

```
# make reproducible
set.seed(1)


# set predicted values based on prior literature
predicted <- tibble(
  context = c("nonstructural", "nonstructural", "structural", "structural"),
  explanation = c("control", "formal", "control", "formal"),

  # means
  essentialism = c(0.590, # nonstructural control ~ Muradoglu et al control condition (exact mean from
                   0.645, # nonstructural formal ~ Muradoglu et al formal condition (exact mean from da
                   1-(3.17-1)/(4-1), # structural control ~ Vasilyeva et al structural condition (eyeba
                   1-(3.17-1)/(4-1)), # structural formal ~ we predict to be the same as structural con

  # where do the SDs come into the power analysis?
  sd = c(0.475, # nonstructural control ~ Muradoglu et al control condition (exact SD from data)
         0.463, # nonstructural formal ~ Muradoglu et al formal condition (exact SD from data)
         (0.65/3.5)/(4-1)*sqrt(24), # structural control ~ Vasilyeva et al structural condition (estima
         (0.65/3.5)/(4-1)*sqrt(24))
)


# set parameters for linear model:
# essentialism = nonstructural + formal * x1 + structural * x2 + formalStructural * x1 * x2
b0 = predicted$essentialism[1] # b0 = nonstructural_control
b1 = predicted$essentialism[2] - b0 # nonstructural_formal = b0 + b1 -> b1 = nonstructural_formal - b0
b2 = predicted$essentialism[3] - b0 # structural_control = b0 + b2 -> b2 = structural_control - b0
```

```r
b3 = predicted$essentialism[4] - b0 - b1 - b2 # structural_formal = b0 + b1 + b2 + b3 -> b3 = structura


# make a function to simulate linear regression
regression_sim <- function(simNum, n, b0, b1, b2, b3) {
    x1 <- sample(0:1, n, replace = TRUE) # formalTRUE is either 0 or 1
    x2 <- sample(0:1, n, replace = TRUE) # structuralTRUE is either 0 or 1

    # essentialism <- b0 + (b1 * formalTRUE) + (b2 * structuralTRUE) + (b3 * formalTRUE * structuralTRU
    y <- b0 + (b1 * x1) + (b2 * x2) + (b3 * x1 * x2) +
      # residual error
      rnorm(n, mean = 0, sd = 1) # how to set the mean and sd of residual?

    model <- lm(y ~ x1 * x2)
    summary(model)

    output <- summary(model)$coefficients
    coefs <- output[, 1]
    ps <- output[, 4]

    rsq <- summary(model)$r.squared

    results <- c(coefs, ps, rsq)
    names(results) <- c('b0_coef', 'b1_coef', 'b2_coef', 'b3_coef',
                        'b0_p', 'b1_p', 'b2_p', 'b3_p', 'rsq')
    return(results)
}

# run simulation with different ns, and different b3 (interaction effect sizes)
paramtest_results <- grid_search(regression_sim,
    params = list(n = c(100, 120, 140), # try different n
                  b3 = c(b3 * 1.1, b3, b3 * 0.9)), # try different values for b3 (context and explanati
    n.iter=1000,
    output='data.frame',
    parallel='snow',
    ncpus=3,
    b0 = b0, b1 = b1, b2 = b2)
```

```
## Running 9,000 tests...
```

```r
# calculate power
power <- paramtest_results$results %>%
  group_by(n.test, b3.test) %>%
  summarize(power = sum(b3_p < .05) / n())
power
```

```
## # A tibble: 9 x 3
## # Groups:   n.test [3]
##   n.test b3.test power
##    <dbl>   <dbl> <dbl>
## 1    100 -0.0605 0.055
## 2    100 -0.055  0.05
## 3    100 -0.0495 0.049
```

```
## 4    120 -0.0605 0.052
## 5    120 -0.055  0.043
## 6    120 -0.0495 0.05
## 7    140 -0.0605 0.061
## 8    140 -0.055  0.06
## 9    140 -0.0495 0.044
```

```
# # set alpha and the number of simulations
# alpha = 0.05
# n_simulations = 1000
#
# # set up the simulation grid
# df.pwr = crossing(n = seq(80, 120, 1),
#                   simulation = 1:n_simulations,
#                   alpha = alpha)
#
# # draw random samples from the normal distributions, save the random samples in lists like so:
# df.pwr = df.pwr %>%
#   group_by(n, simulation) %>% # your simulation counter
#   mutate(nonstructural_control = rnorm(n, mean = predicted$essentialism[1], sd = predicted$sd[1]) %>%
#          nonstructural_formal = rnorm(n, mean = predicted$essentialism[2], sd = predicted$sd[2]) %>%
#          structural_control = rnorm(n, mean = predicted$essentialism[3], sd = predicted$sd[3]) %>% li
#          structural_formal = rnorm(n, mean = predicted$essentialism[4], sd = predicted$sd[4]) %>% lis
#
#
#
# # calculate anovas for each sample
# ## hint: group by simulation first and then nest the data before using map()
# df.pwr <- df.pwr %>%
#   group_by(n, simulation) %>%
#   nest() %>%
#   mutate(anova = tidy(map(data, ~ aov(.$essentialism ~ 1 + .$context * .$explanation, .))), #this doe
#          p_value = map(anova, ~ .$p.value[3]))
#
#
#
# # calculate the proportion with which the H0 would be rejected (= power)
# df.pwr %>%
#   group_by(n) %>%
#   summarize(power = sum(p_value < .05) / n())
```

Power is extremely low for all n and b3 tested - what's going on? Does it have to do with the mean/SD of the residual? Do I need to incorporate the SD of the predicted data somehow?

Power Analysis based on bootstrapping pilot data

```
# pwr.t.test(d = cohensD(essentialism ~ context * explanation, data = df.means_subj),
#            power = 0.8,
#            sig.level = 0.05)
```

Discussion