

Cognates Project

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Study

- Idea: How do multilingual readers at different proficiency levels perceive cognates and false friends?
- Participants: Portuguese-Spanish-English trilinguals in Ceará, Brazil reading *English* (L3) sentences with embedded cognate or control words
- If there is no cross-talk between languages:
 - Effects of visual similarity alone
 - Maybe stronger if you know the word in two languages?
- If there is an influence of native language/L2:
 - Effects of visual similarity plus effects of semantic overlap (e.g. “total” is faster to process than “sensible”)
 - Effect should be stronger if you are better at the L2 (more conflict between “sensible” and the meaning of “sensitive”)
 - All false friends with English were true cognates between Spanish and Portuguese
- Plus visual noise manipulation

Example cognates and controls

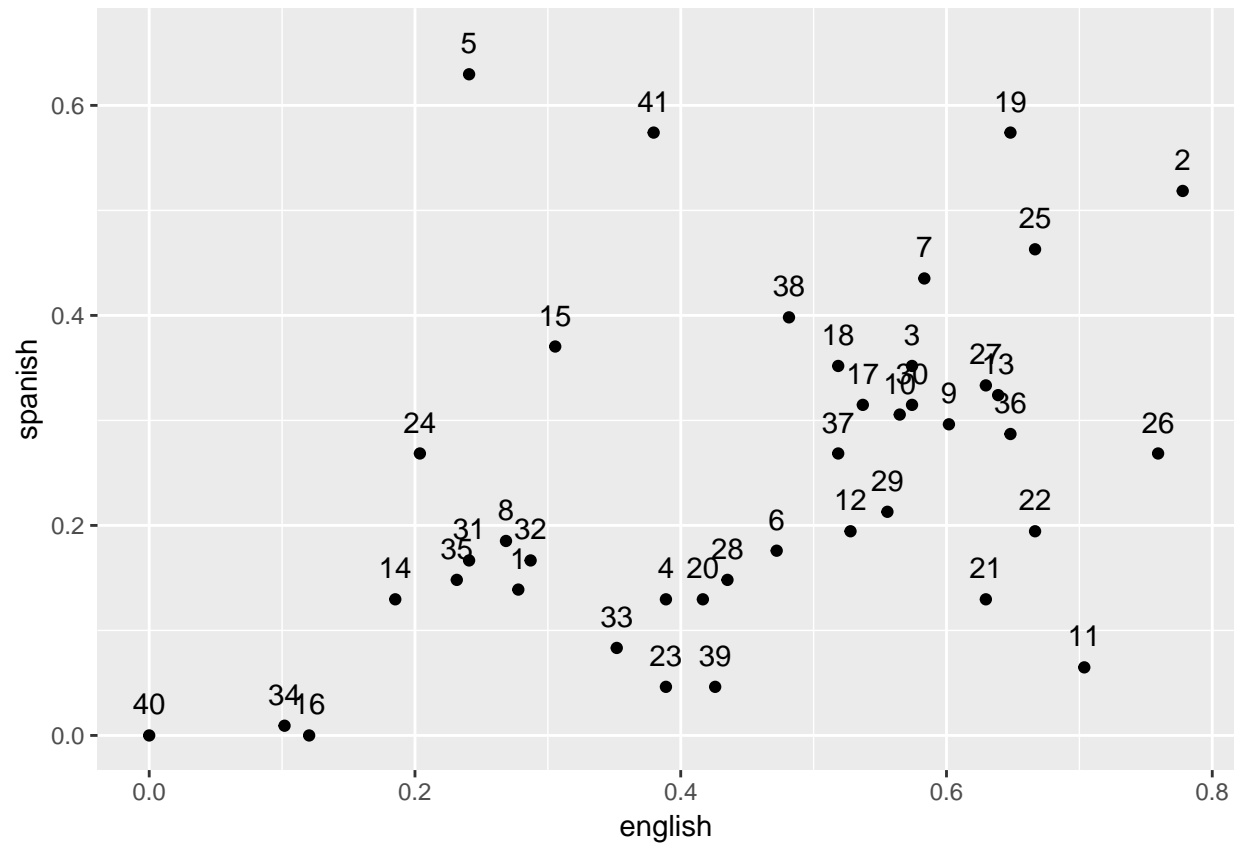
English	Similar_Word_PT	Similar_Word_SP	freq_per_million.x	SOLAR_PT_EN	SOLAR_SP_EN	SOLAR
actor	ator	actor	22.030173	0.95	1.00	
clerk	escriturário	empleado	19.645521	0.11	0.20	
cereal	cereal	cereal	4.702445	1.00	1.00	
pepper	pimenta	pimienta	10.430067	0.30	0.23	
error	erro	error	41.174249	0.83	1.00	
laugh	risada	risa	36.872961	0.12	0.17	

Example stimuli

```
stim %>%  
  dplyr::select(experimental_sentence, filler_sentence)%>%  
  head %>%  
  kable
```

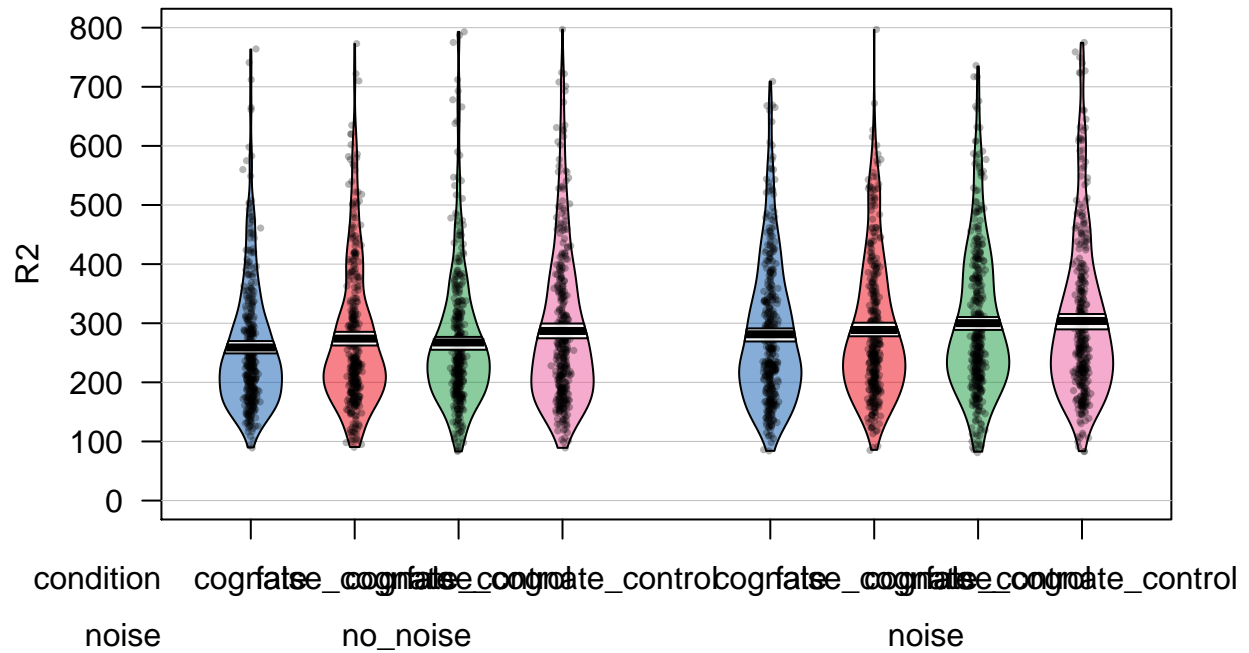
experimental_sentence	filler_sentence
Carl argued that his father’s error was similar to his own.	Carl argued that his father’s laugh was similar to his own.
Bob saw that the piano was beautiful.	Bob saw that the bench was beautiful.
They said that the origin could not be determined.	They said that the winner could not be determined.
The neighbors said that the destruction came as a complete surprise.	The neighbors said that the improvement came as a surprise.
They thought that their assumption would never be questioned.	They thought that their friendship would never be questioned.
They said that the inspector was nervous during the trial.	They said that the plaintiff was nervous during the trial.

Participant proficiency



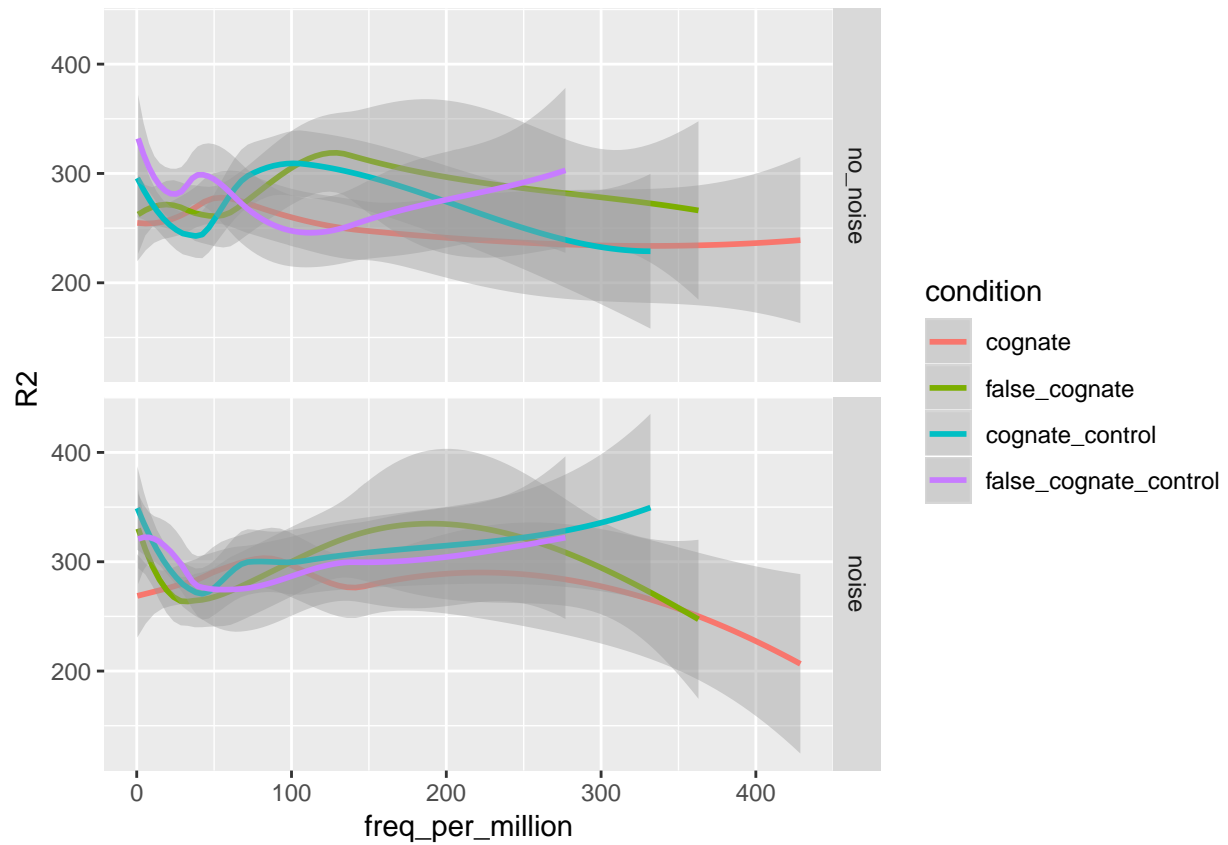
Excluding participants 16, 34, 40 because of very low English proficiency

Results: FFD



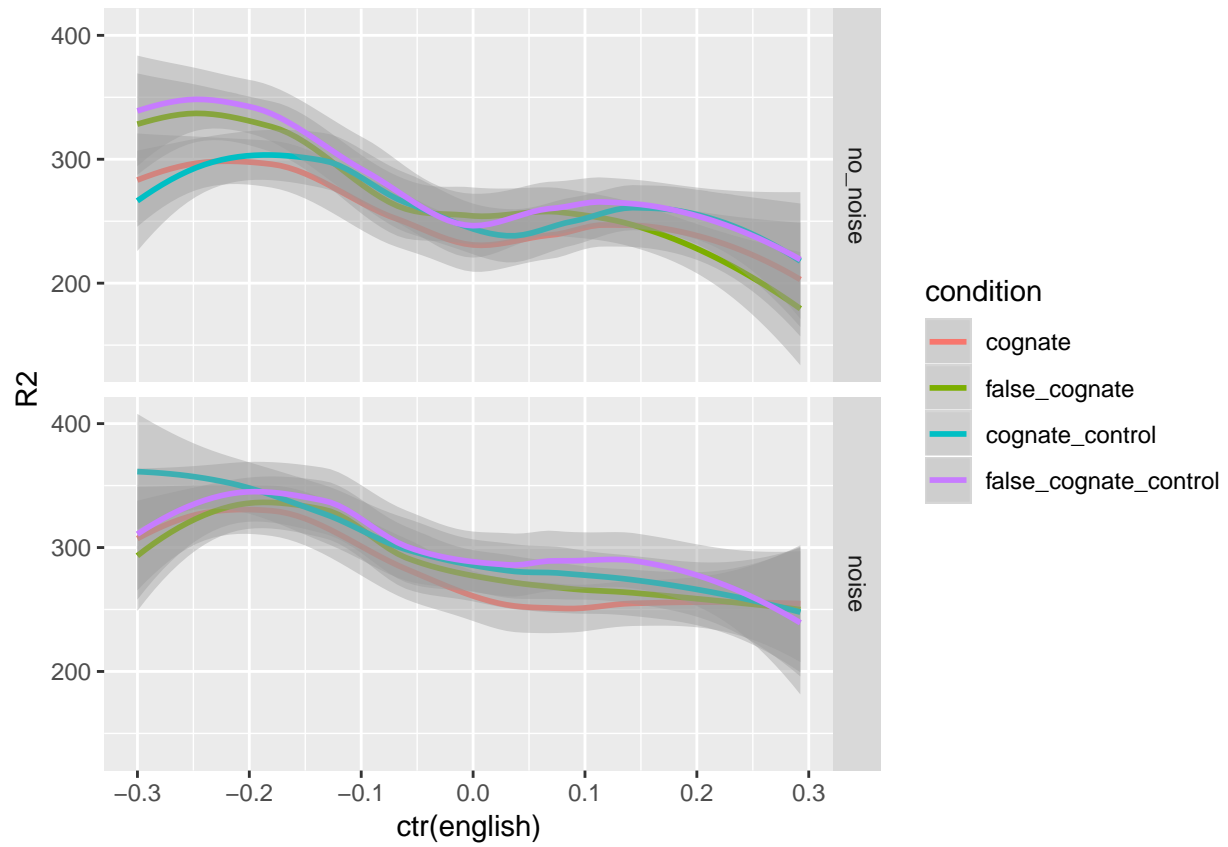
```
## `geom_smooth()` using method = 'loess' and formula 'y ~ x'
```

```
## Warning: Removed 320 rows containing non-finite values (stat_smooth).
```



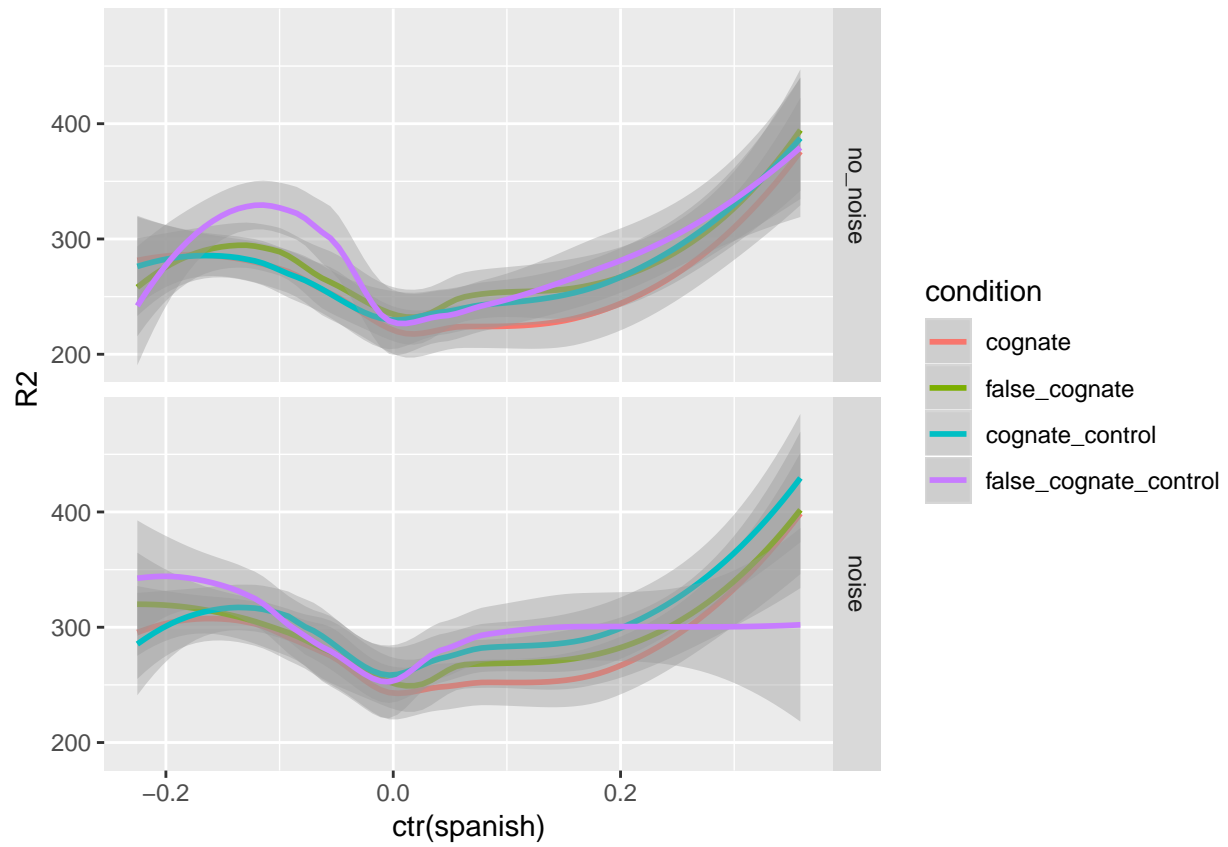
```
## `geom_smooth()` using method = 'loess' and formula 'y ~ x'
```

```
## Warning: Removed 320 rows containing non-finite values (stat_smooth).
```



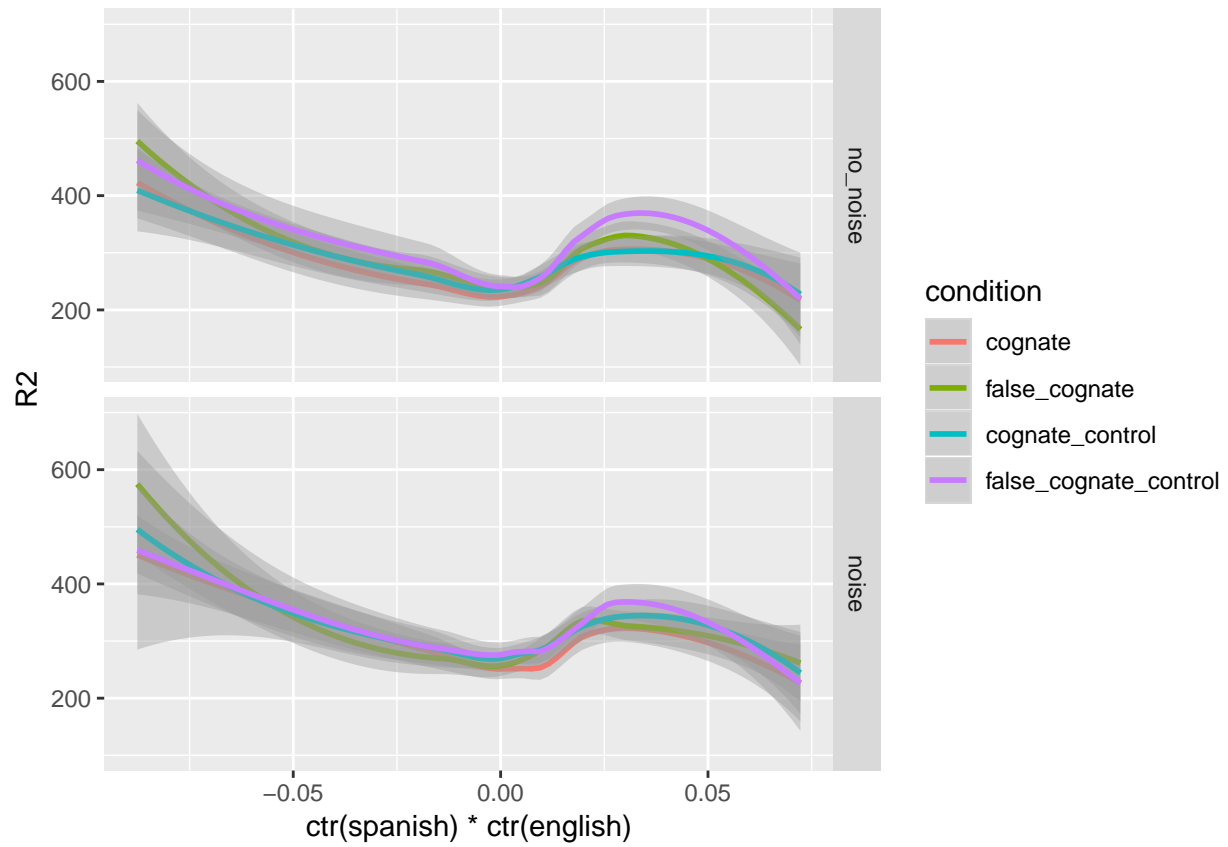
```
## `geom_smooth()` using method = 'loess' and formula 'y ~ x'
```

```
## Warning: Removed 320 rows containing non-finite values (stat_smooth).
```



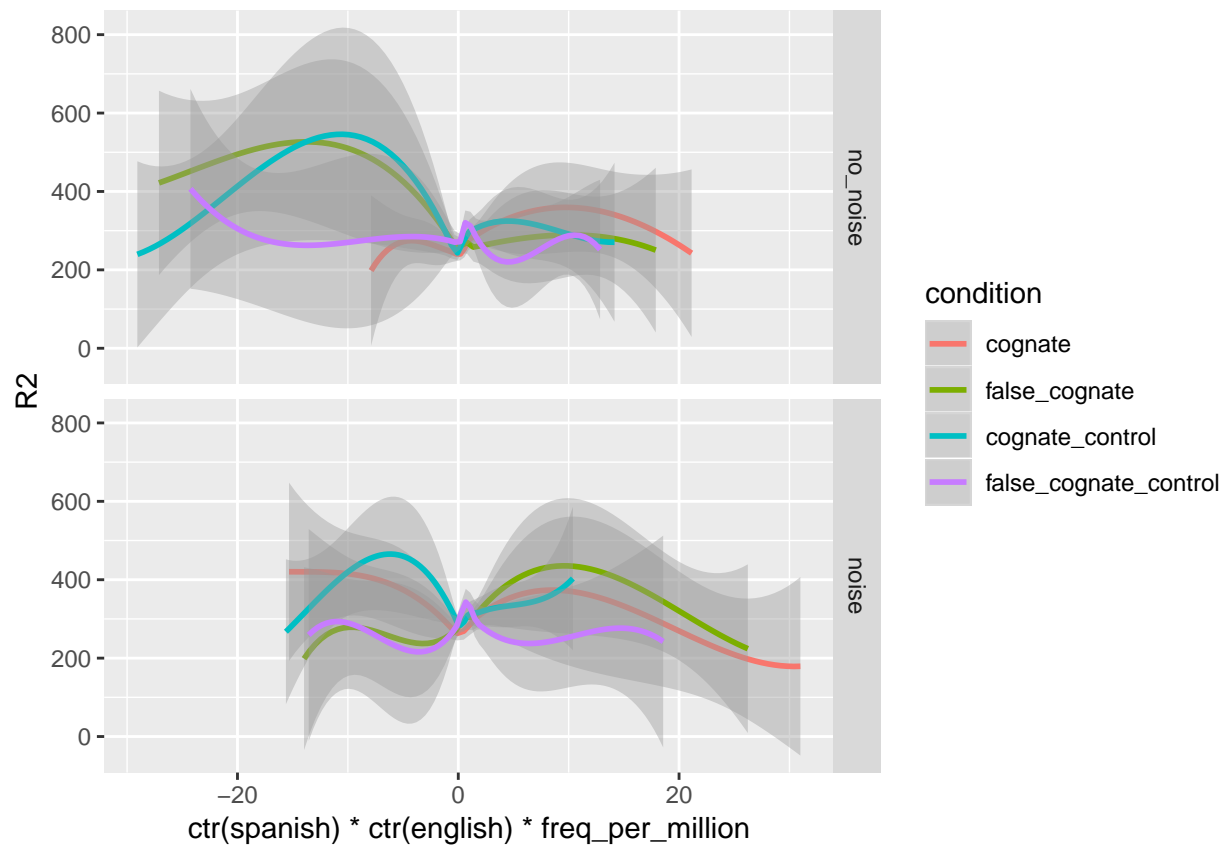
```
## `geom_smooth()` using method = 'loess' and formula 'y ~ x'
```

```
## Warning: Removed 320 rows containing non-finite values (stat_smooth).
```

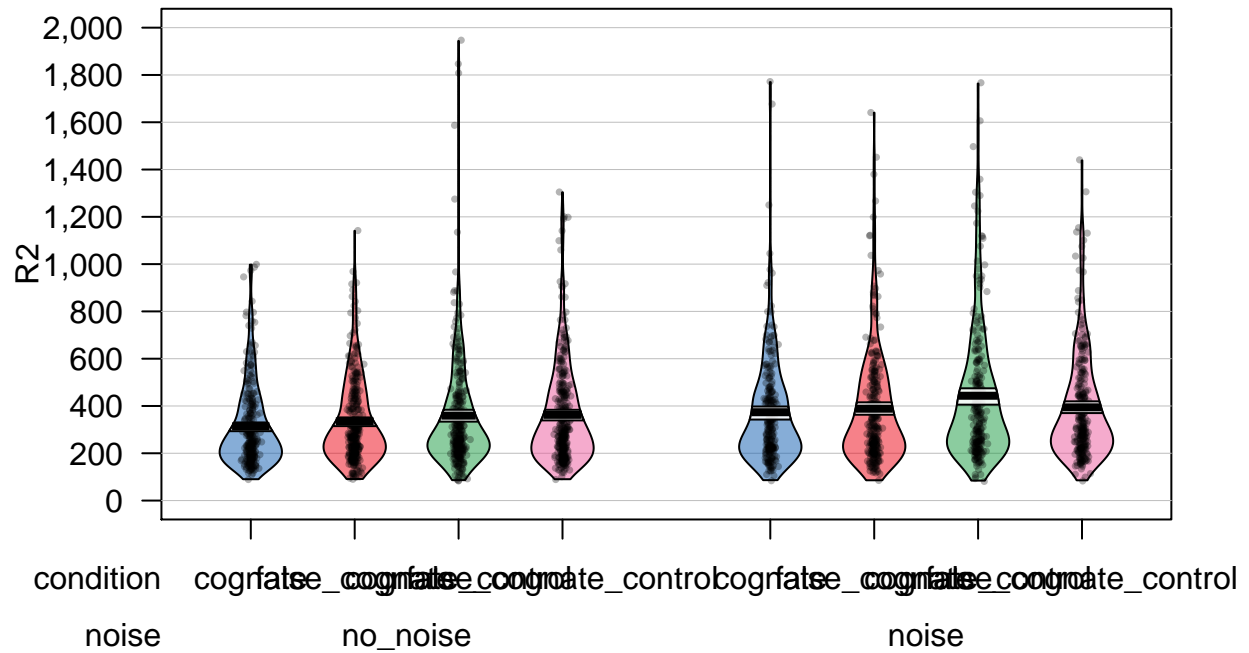


```
## `geom_smooth()` using method = 'loess' and formula 'y ~ x'
```

```
## Warning: Removed 320 rows containing non-finite values (stat_smooth).
```

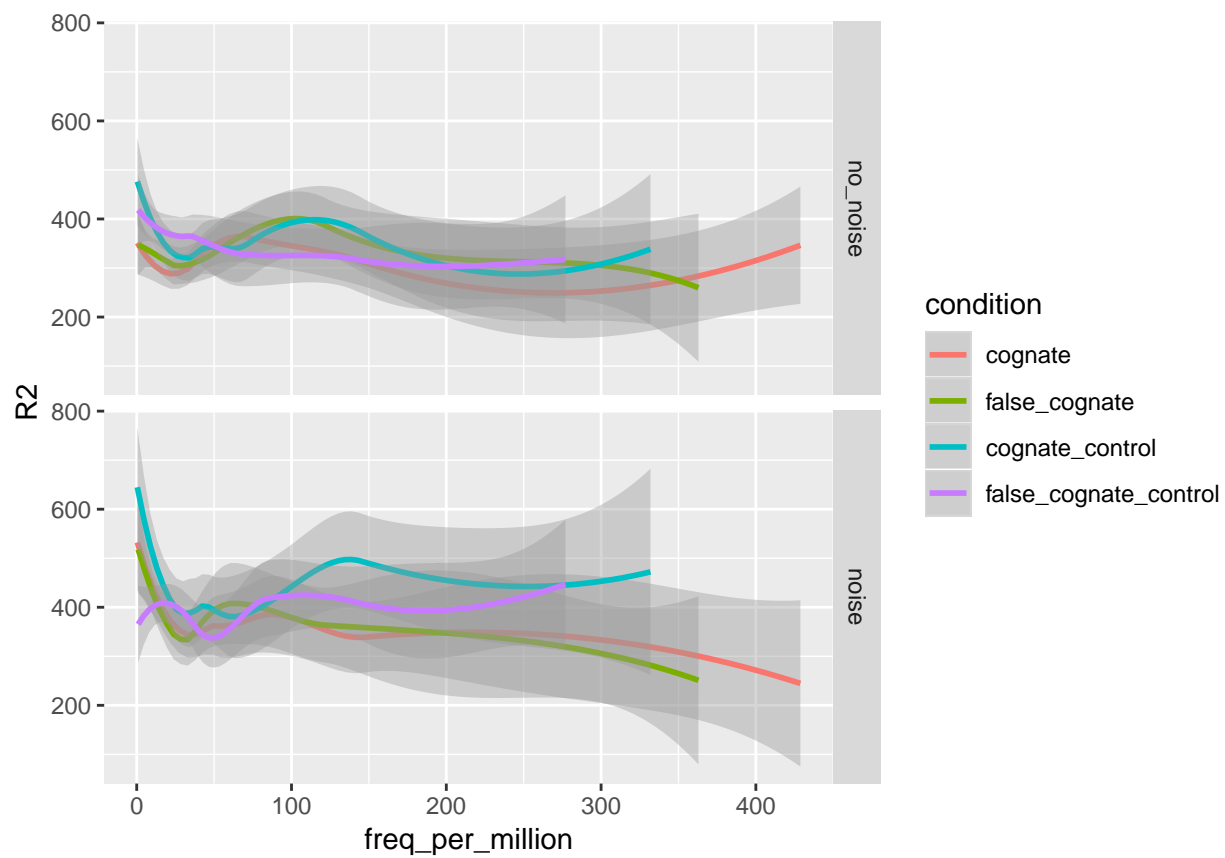


Results: Gaze duration



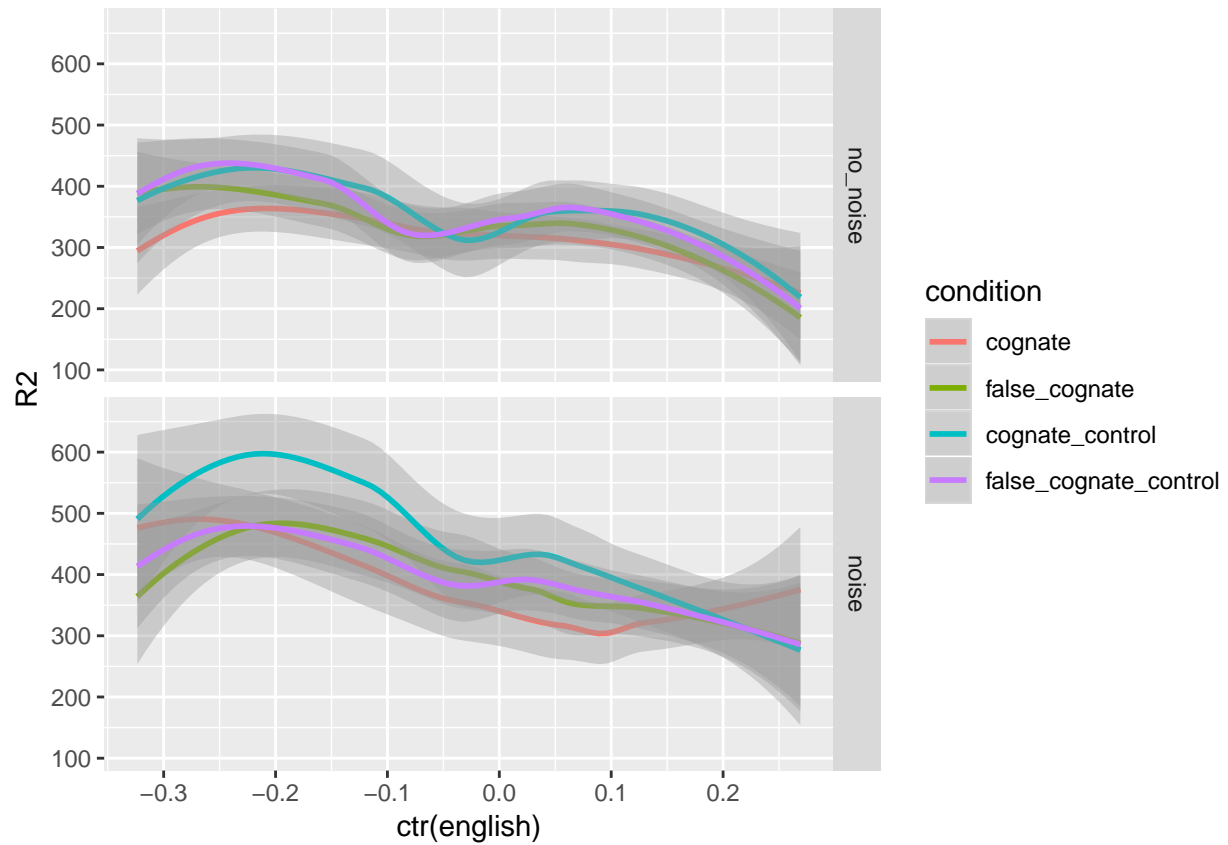
```
## `geom_smooth()` using method = 'loess' and formula 'y ~ x'
```

```
## Warning: Removed 227 rows containing non-finite values (stat_smooth).
```



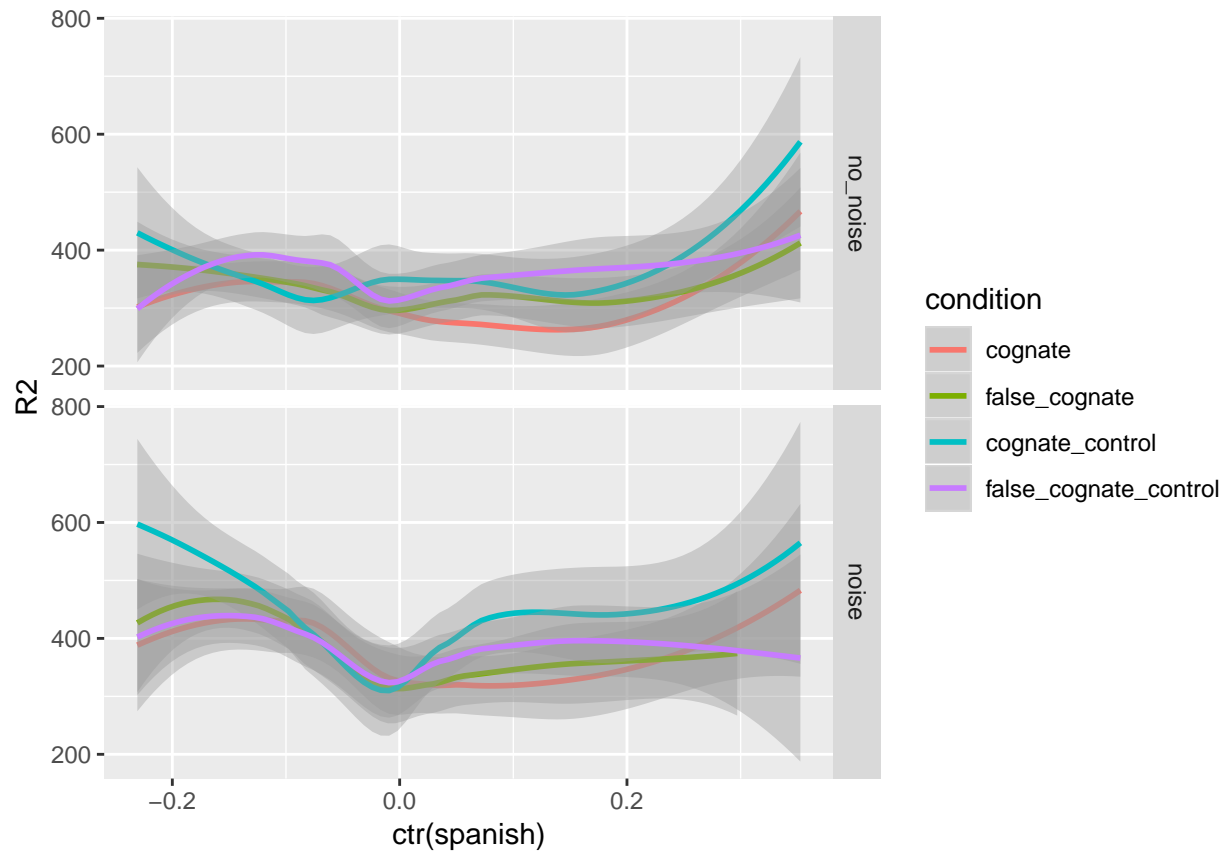
```
## `geom_smooth()` using method = 'loess' and formula 'y ~ x'
```

```
## Warning: Removed 227 rows containing non-finite values (stat_smooth).
```



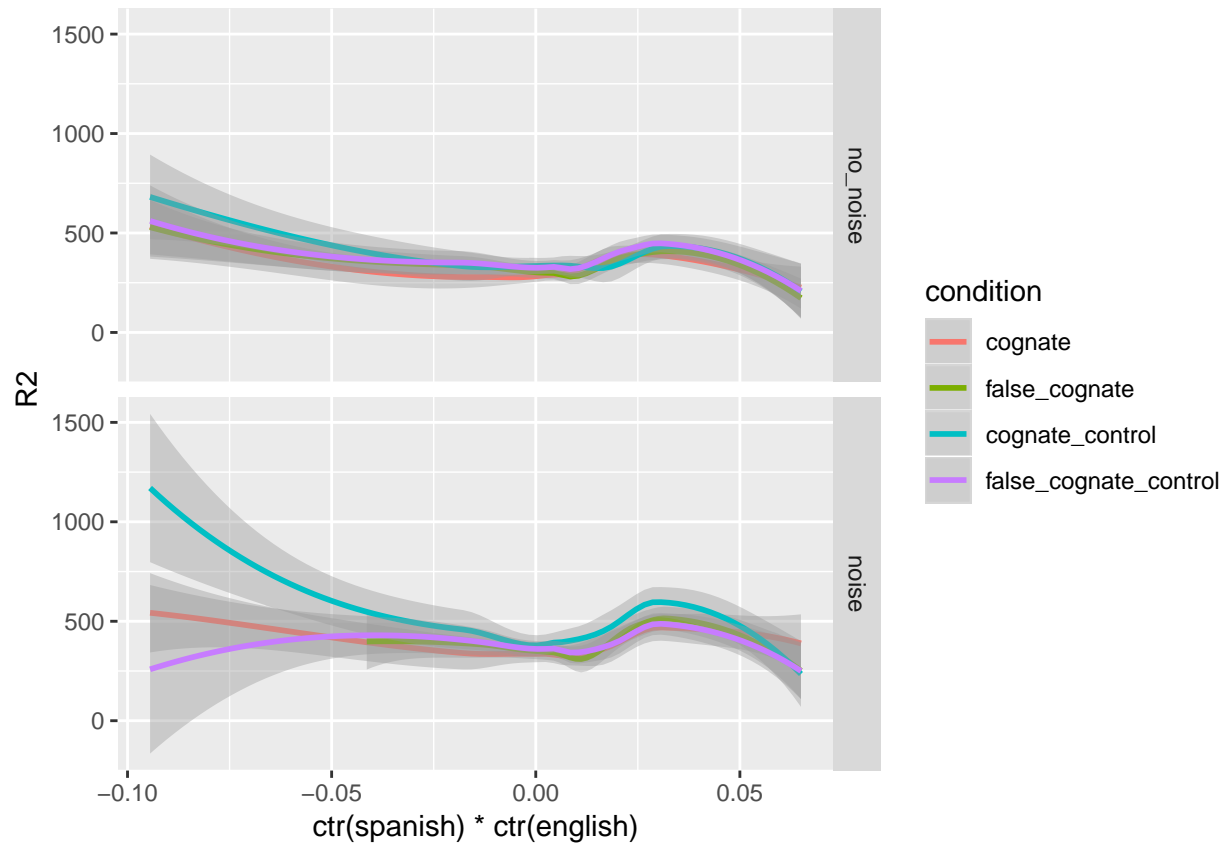
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## `geom_smooth()` using method = 'loess' and formula 'y ~ x'
```

```
## Warning: Removed 227 rows containing non-finite values (stat_smooth).
```



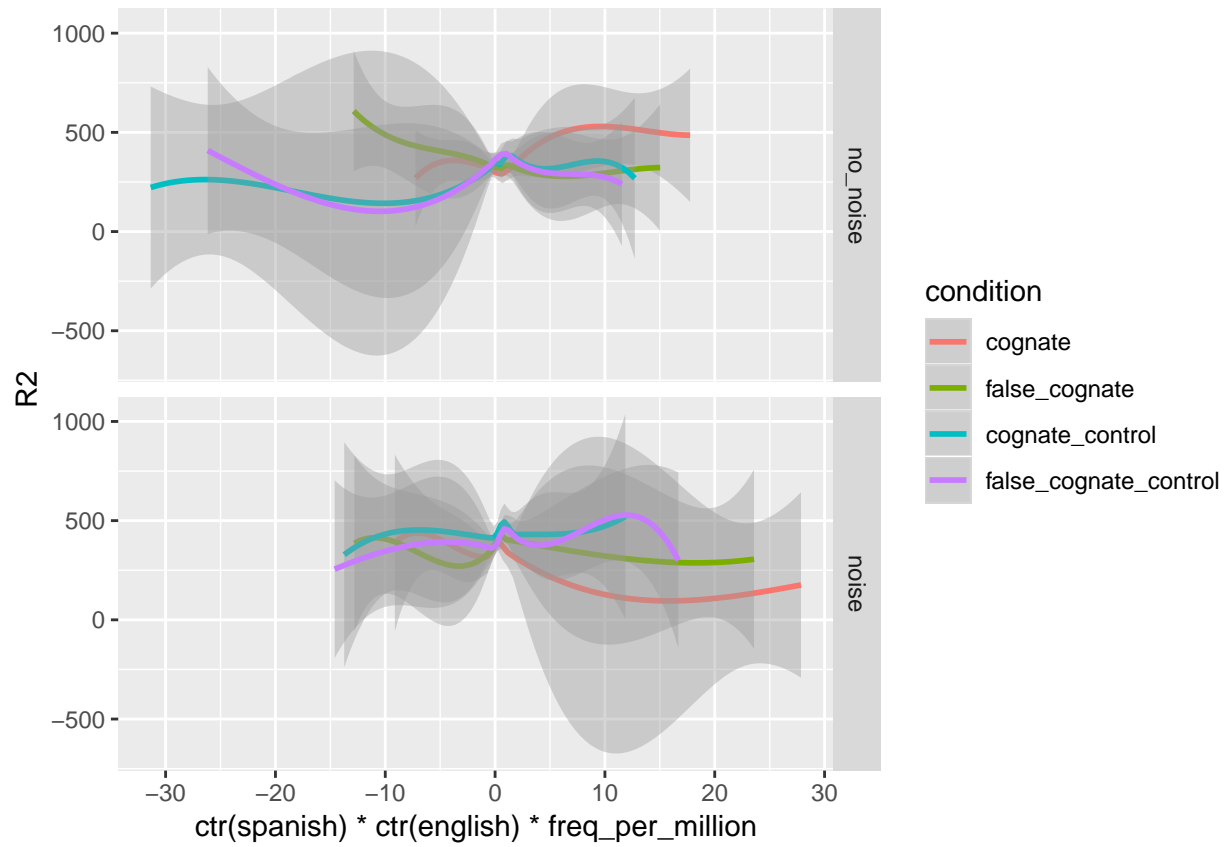
```
## `geom_smooth()` using method = 'loess' and formula 'y ~ x'
```

```
## Warning: Removed 227 rows containing non-finite values (stat_smooth).
```

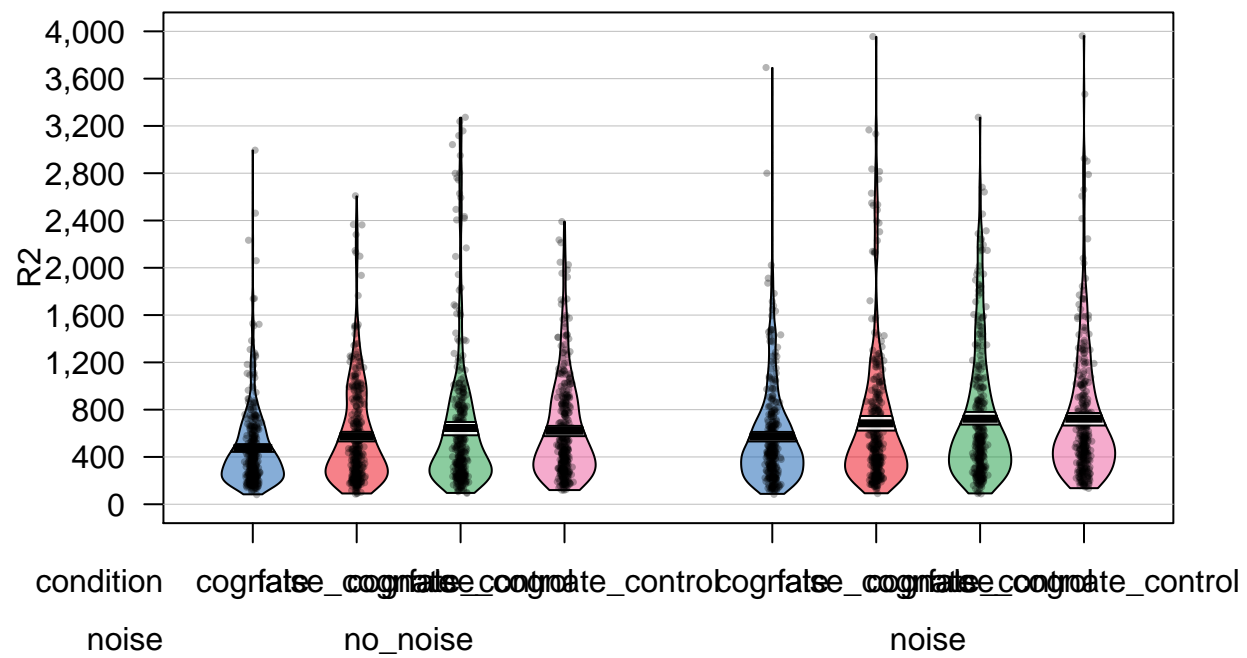


```
## `geom_smooth()` using method = 'loess' and formula 'y ~ x'
```

```
## Warning: Removed 227 rows containing non-finite values (stat_smooth).
```

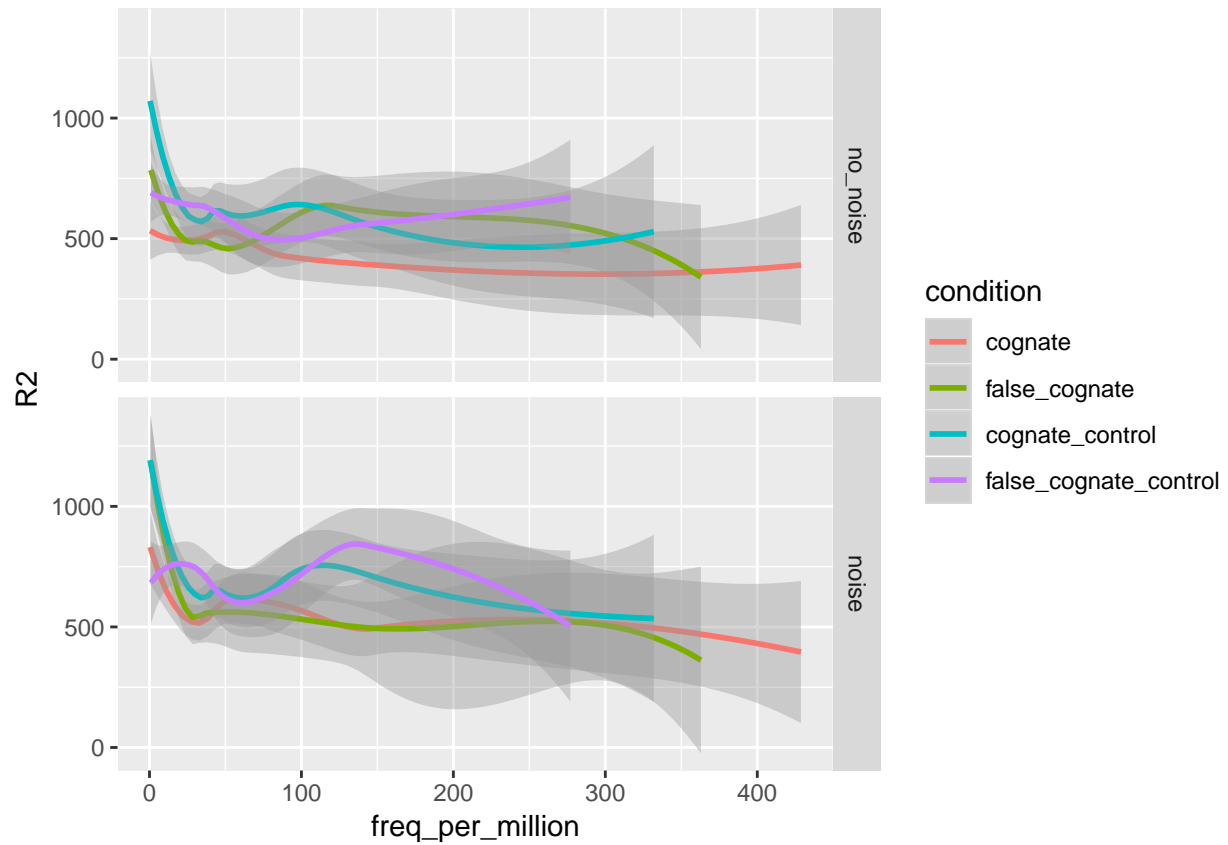


Results: TVT



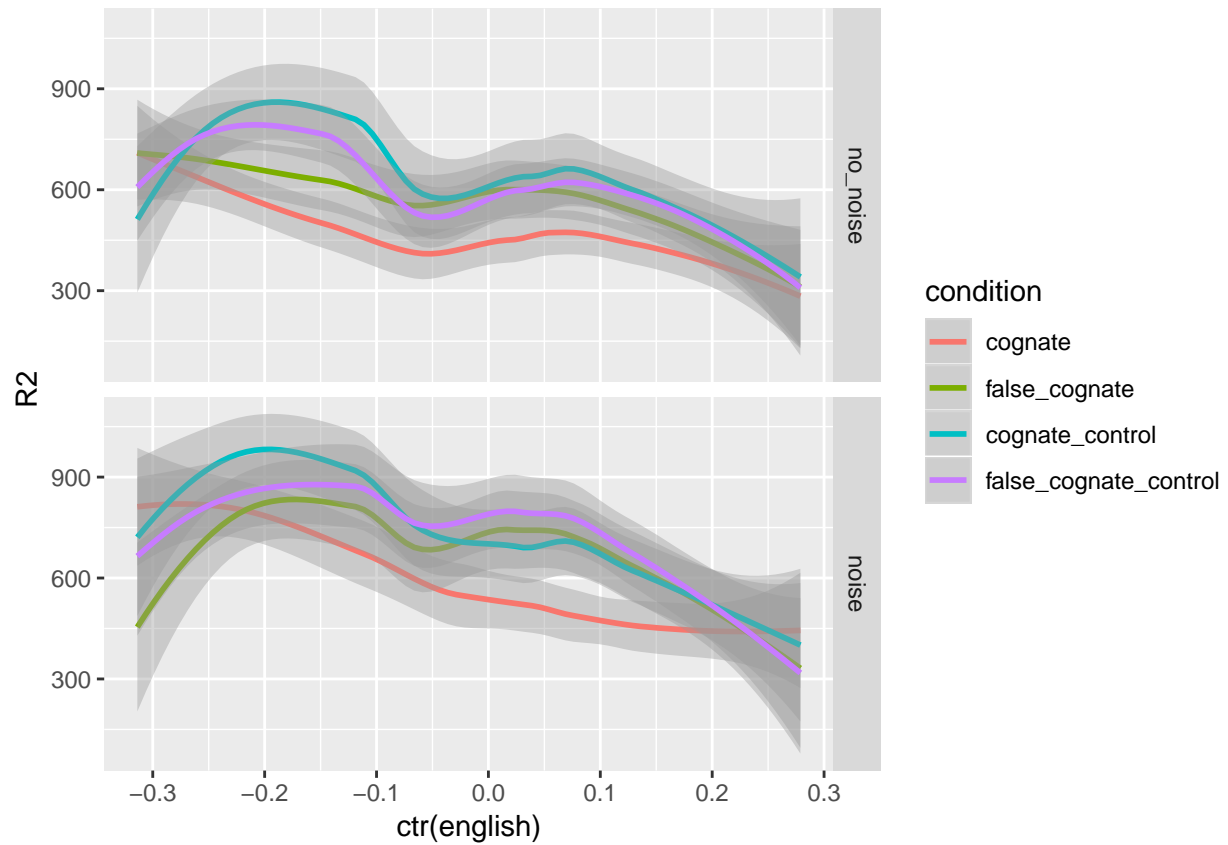
```
## `geom_smooth()` using method = 'loess' and formula 'y ~ x'
```

```
## Warning: Removed 140 rows containing non-finite values (stat_smooth).
```



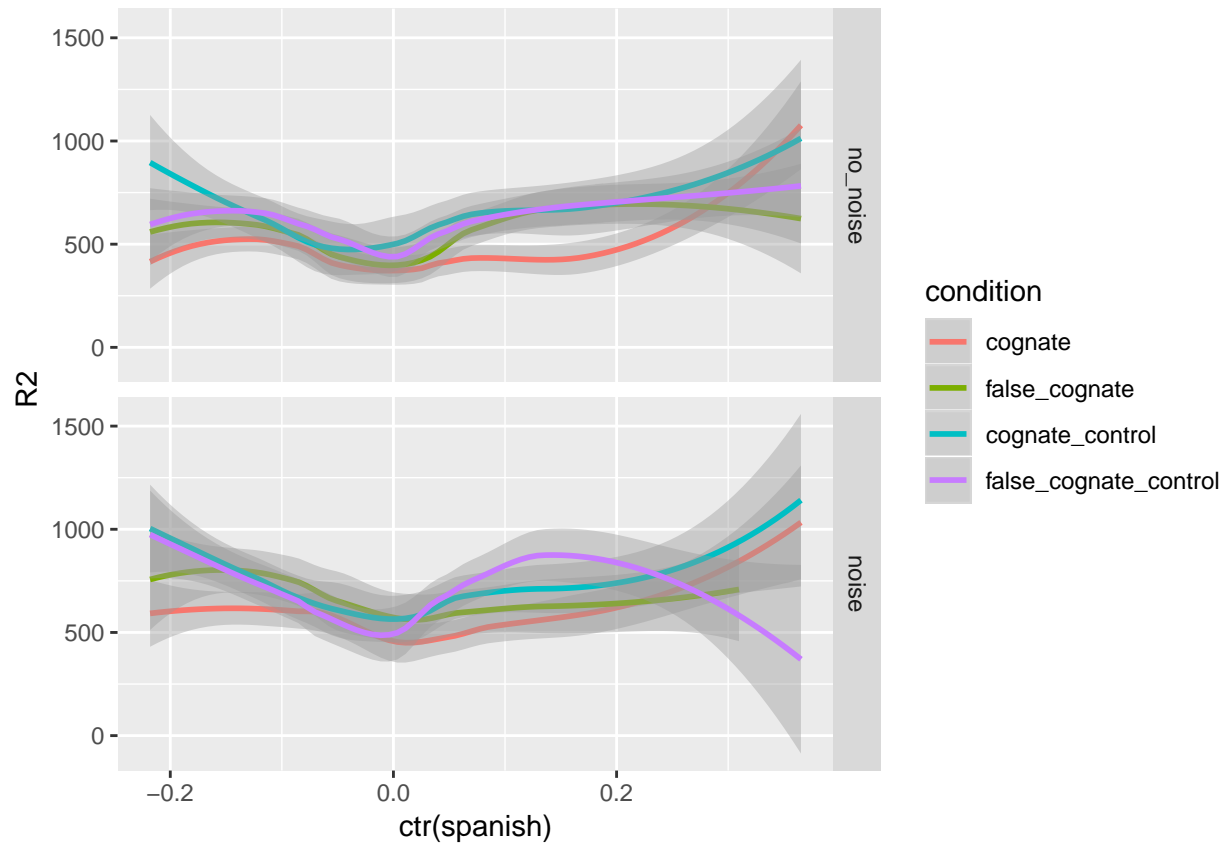
```
## `geom_smooth()` using method = 'loess' and formula 'y ~ x'
```

```
## Warning: Removed 140 rows containing non-finite values (stat_smooth).
```

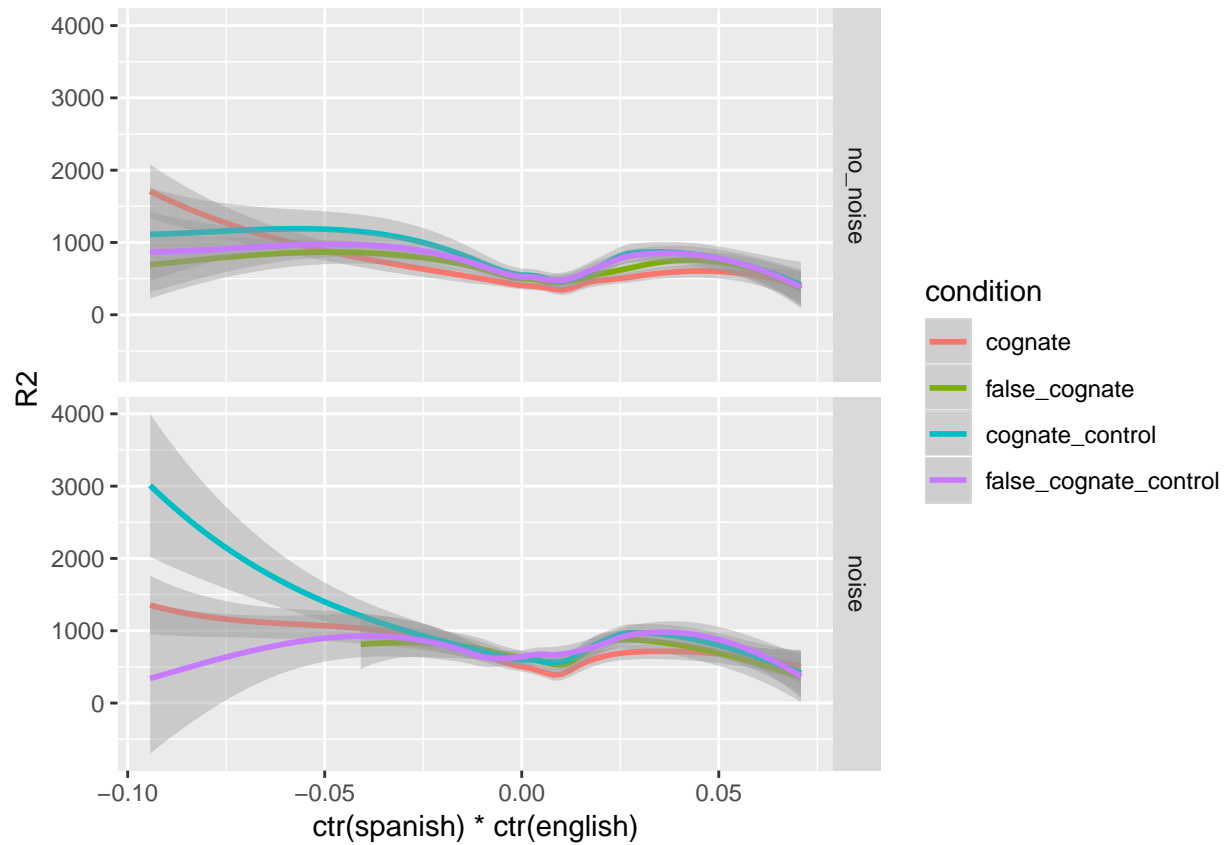
```
## `geom_smooth()` using method = 'loess' and formula 'y ~ x'
```

```
## Warning: Removed 140 rows containing non-finite values (stat_smooth).
```



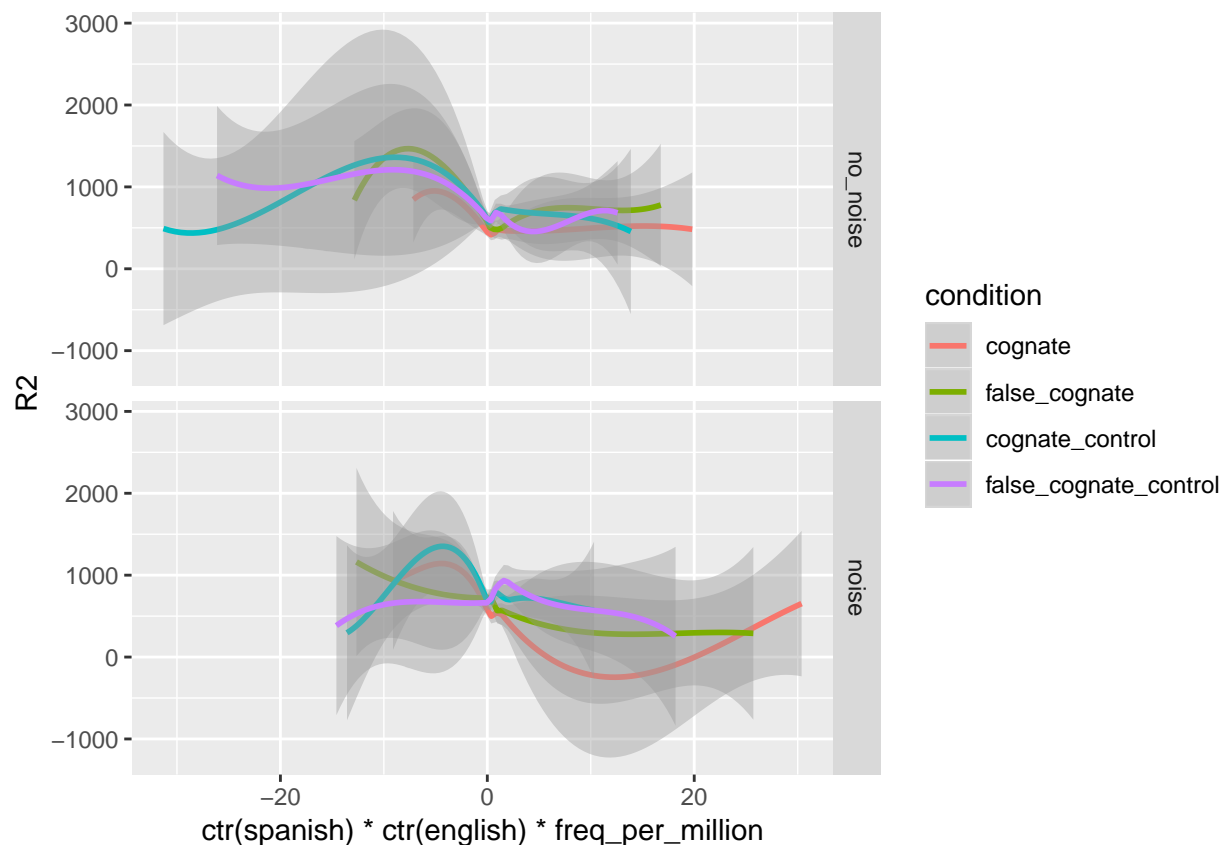
```
## `geom_smooth()` using method = 'loess' and formula 'y ~ x'
```

```
## Warning: Removed 140 rows containing non-finite values (stat_smooth).
```



```
## `geom_smooth()` using method = 'loess' and formula 'y ~ x'
```

```
## Warning: Removed 140 rows containing non-finite values (stat_smooth).
```



```
## Linear mixed model fit by REML ['lmerMod']
## Formula:
## R2 ~ condition * noise * ctr(english) * ctr(spanish) * ctr(1/freq_per_million) +
##   (1 | subj) + (1 | item)
## Data: FFD %>% filter(!(subj %in% c(16, 34, 40)))
##
## REML criterion at convergence: 35953.9
##
## Scaled residuals:
##   Min       1Q   Median       3Q      Max
## -2.9097 -0.6350 -0.1437  0.4500  4.7997
##
## Random effects:
##   Groups   Name                Variance Std.Dev.
##   item     (Intercept)         140.2    11.84
##   subj     (Intercept)       2458.4    49.58
##   Residual                    11378.4   106.67
## Number of obs: 2997, groups:  item, 100; subj, 38
##
## Fixed effects:
##
## (Intercept)                                Estimate
## conditioncognate_vs_control                 13.3871
## conditioncontrol_vs_fc_control             -11.9526
## conditiontrue_vs_false_cognate              0.5088
## noise1                                      12.2212
```

## ctr(english)	-201.5014
## ctr(spanish)	69.5194
## ctr(1/freq_per_million)	29.0889
## conditioncognate_vs_control:noise1	5.1039
## conditioncontrol_vs_fc_control:noise1	8.0506
## conditiontrue_vs_false_cognate:noise1	2.7903
## conditioncognate_vs_control:ctr(english)	-19.5512
## conditioncontrol_vs_fc_control:ctr(english)	14.0296
## conditiontrue_vs_false_cognate:ctr(english)	-34.8426
## noise1:ctr(english)	1.3470
## conditioncognate_vs_control:ctr(spanish)	68.1714
## conditioncontrol_vs_fc_control:ctr(spanish)	81.8344
## conditiontrue_vs_false_cognate:ctr(spanish)	70.3774
## noise1:ctr(spanish)	-8.8572
## ctr(english):ctr(spanish)	-380.6226
## conditioncognate_vs_control:ctr(1/freq_per_million)	-2.8605
## conditioncontrol_vs_fc_control:ctr(1/freq_per_million)	-32.5773
## conditiontrue_vs_false_cognate:ctr(1/freq_per_million)	20.0440
## noise1:ctr(1/freq_per_million)	6.5924
## ctr(english):ctr(1/freq_per_million)	-51.6251
## ctr(spanish):ctr(1/freq_per_million)	109.1701
## conditioncognate_vs_control:noise1:ctr(english)	-42.6424
## conditioncontrol_vs_fc_control:noise1:ctr(english)	-91.1902
## conditiontrue_vs_false_cognate:noise1:ctr(english)	-24.8248
## conditioncognate_vs_control:noise1:ctr(spanish)	31.2186
## conditioncontrol_vs_fc_control:noise1:ctr(spanish)	71.8078
## conditiontrue_vs_false_cognate:noise1:ctr(spanish)	38.7973
## conditioncognate_vs_control:ctr(english):ctr(spanish)	165.9799
## conditioncontrol_vs_fc_control:ctr(english):ctr(spanish)	-4.7578
## conditiontrue_vs_false_cognate:ctr(english):ctr(spanish)	-47.8478
## noise1:ctr(english):ctr(spanish)	-87.0075
## conditioncognate_vs_control:noise1:ctr(1/freq_per_million)	8.6663
## conditioncontrol_vs_fc_control:noise1:ctr(1/freq_per_million)	-6.5505
## conditiontrue_vs_false_cognate:noise1:ctr(1/freq_per_million)	28.6178
## conditioncognate_vs_control:ctr(english):ctr(1/freq_per_million)	115.2709
## conditioncontrol_vs_fc_control:ctr(english):ctr(1/freq_per_million)	52.9554
## conditiontrue_vs_false_cognate:ctr(english):ctr(1/freq_per_million)	-111.1976
## noise1:ctr(english):ctr(1/freq_per_million)	-84.1234
## conditioncognate_vs_control:ctr(spanish):ctr(1/freq_per_million)	-391.8718
## conditioncontrol_vs_fc_control:ctr(spanish):ctr(1/freq_per_million)	178.4532
## conditiontrue_vs_false_cognate:ctr(spanish):ctr(1/freq_per_million)	225.8766
## noise1:ctr(spanish):ctr(1/freq_per_million)	-45.3652
## ctr(english):ctr(spanish):ctr(1/freq_per_million)	-1021.5147
## conditioncognate_vs_control:noise1:ctr(english):ctr(spanish)	67.3885
## conditioncontrol_vs_fc_control:noise1:ctr(english):ctr(spanish)	123.8209
## conditiontrue_vs_false_cognate:noise1:ctr(english):ctr(spanish)	143.0076
## conditioncognate_vs_control:noise1:ctr(english):ctr(1/freq_per_million)	-100.2090
## conditioncontrol_vs_fc_control:noise1:ctr(english):ctr(1/freq_per_million)	323.3809
## conditiontrue_vs_false_cognate:noise1:ctr(english):ctr(1/freq_per_million)	10.8552
## conditioncognate_vs_control:noise1:ctr(spanish):ctr(1/freq_per_million)	93.9079
## conditioncontrol_vs_fc_control:noise1:ctr(spanish):ctr(1/freq_per_million)	503.4867
## conditiontrue_vs_false_cognate:noise1:ctr(spanish):ctr(1/freq_per_million)	602.6689
## conditioncognate_vs_control:ctr(english):ctr(spanish):ctr(1/freq_per_million)	894.3708
## conditioncontrol_vs_fc_control:ctr(english):ctr(spanish):ctr(1/freq_per_million)	1695.0176

## conditiontrue_vs_false_cognate:ctr(english):ctr(spanish):ctr(1/freq_per_million)	-188.8848
## noise1:ctr(english):ctr(spanish):ctr(1/freq_per_million)	-1095.4264
## conditioncognate_vs_control:noise1:ctr(english):ctr(spanish):ctr(1/freq_per_million)	227.0271
## conditioncontrol_vs_fc_control:noise1:ctr(english):ctr(spanish):ctr(1/freq_per_million)	3319.1178
## conditiontrue_vs_false_cognate:noise1:ctr(english):ctr(spanish):ctr(1/freq_per_million)	680.8293
##	Std. Error
## (Intercept)	8.6278
## conditioncognate_vs_control	5.6484
## conditioncontrol_vs_fc_control	6.2851
## conditiontrue_vs_false_cognate	4.1140
## noise1	2.0559
## ctr(english)	52.5039
## ctr(spanish)	58.3126
## ctr(1/freq_per_million)	11.9976
## conditioncognate_vs_control:noise1	5.6400
## conditioncontrol_vs_fc_control:noise1	5.8070
## conditiontrue_vs_false_cognate:noise1	4.1064
## conditioncognate_vs_control:ctr(english)	34.3487
## conditioncontrol_vs_fc_control:ctr(english)	35.5717
## conditiontrue_vs_false_cognate:ctr(english)	25.0351
## noise1:ctr(english)	12.5879
## conditioncognate_vs_control:ctr(spanish)	38.6848
## conditioncontrol_vs_fc_control:ctr(spanish)	40.8563
## conditiontrue_vs_false_cognate:ctr(spanish)	28.7213
## noise1:ctr(spanish)	14.4157
## ctr(english):ctr(spanish)	321.5090
## conditioncognate_vs_control:ctr(1/freq_per_million)	20.5888
## conditioncontrol_vs_fc_control:ctr(1/freq_per_million)	30.6378
## conditiontrue_vs_false_cognate:ctr(1/freq_per_million)	22.1184
## noise1:ctr(1/freq_per_million)	10.9313
## ctr(english):ctr(1/freq_per_million)	66.7364
## ctr(spanish):ctr(1/freq_per_million)	90.9840
## conditioncognate_vs_control:noise1:ctr(english)	34.5150
## conditioncontrol_vs_fc_control:noise1:ctr(english)	35.7024
## conditiontrue_vs_false_cognate:noise1:ctr(english)	25.1364
## conditioncognate_vs_control:noise1:ctr(spanish)	38.7782
## conditioncontrol_vs_fc_control:noise1:ctr(spanish)	40.8555
## conditiontrue_vs_false_cognate:noise1:ctr(spanish)	28.7764
## conditioncognate_vs_control:ctr(english):ctr(spanish)	215.3570
## conditioncontrol_vs_fc_control:ctr(english):ctr(spanish)	233.4243
## conditiontrue_vs_false_cognate:ctr(english):ctr(spanish)	162.2803
## noise1:ctr(english):ctr(spanish)	81.0776
## conditioncognate_vs_control:noise1:ctr(1/freq_per_million)	20.4925
## conditioncontrol_vs_fc_control:noise1:ctr(1/freq_per_million)	28.6280
## conditiontrue_vs_false_cognate:noise1:ctr(1/freq_per_million)	21.8740
## conditioncognate_vs_control:ctr(english):ctr(1/freq_per_million)	114.3651
## conditioncontrol_vs_fc_control:ctr(english):ctr(1/freq_per_million)	186.9110
## conditiontrue_vs_false_cognate:ctr(english):ctr(1/freq_per_million)	133.6611
## noise1:ctr(english):ctr(1/freq_per_million)	66.7496
## conditioncognate_vs_control:ctr(spanish):ctr(1/freq_per_million)	161.3112
## conditioncontrol_vs_fc_control:ctr(spanish):ctr(1/freq_per_million)	240.1762
## conditiontrue_vs_false_cognate:ctr(spanish):ctr(1/freq_per_million)	181.9389
## noise1:ctr(spanish):ctr(1/freq_per_million)	90.7623
## ctr(english):ctr(spanish):ctr(1/freq_per_million)	500.8409

## conditioncognate_vs_control:noise1:ctr(english):ctr(spanish)	214.2336
## conditioncontrol_vs_fc_control:noise1:ctr(english):ctr(spanish)	232.8493
## conditiontrue_vs_false_cognate:noise1:ctr(english):ctr(spanish)	161.5621
## conditioncognate_vs_control:noise1:ctr(english):ctr(1/freq_per_million)	114.0953
## conditioncontrol_vs_fc_control:noise1:ctr(english):ctr(1/freq_per_million)	186.8123
## conditiontrue_vs_false_cognate:noise1:ctr(english):ctr(1/freq_per_million)	133.8154
## conditioncognate_vs_control:noise1:ctr(spanish):ctr(1/freq_per_million)	160.5539
## conditioncontrol_vs_fc_control:noise1:ctr(spanish):ctr(1/freq_per_million)	239.3049
## conditiontrue_vs_false_cognate:noise1:ctr(spanish):ctr(1/freq_per_million)	182.0285
## conditioncognate_vs_control:ctr(english):ctr(spanish):ctr(1/freq_per_million)	895.9691
## conditioncontrol_vs_fc_control:ctr(english):ctr(spanish):ctr(1/freq_per_million)	1318.1397
## conditiontrue_vs_false_cognate:ctr(english):ctr(spanish):ctr(1/freq_per_million)	1002.6768
## noise1:ctr(english):ctr(spanish):ctr(1/freq_per_million)	500.3479
## conditioncognate_vs_control:noise1:ctr(english):ctr(spanish):ctr(1/freq_per_million)	891.1622
## conditioncontrol_vs_fc_control:noise1:ctr(english):ctr(spanish):ctr(1/freq_per_million)	1316.3459
## conditiontrue_vs_false_cognate:noise1:ctr(english):ctr(spanish):ctr(1/freq_per_million)	1003.4581
##	t value
## (Intercept)	32.944
## conditioncognate_vs_control	2.370
## conditioncontrol_vs_fc_control	-1.902
## conditiontrue_vs_false_cognate	0.124
## noise1	5.944
## ctr(english)	-3.838
## ctr(spanish)	1.192
## ctr(1/freq_per_million)	2.425
## conditioncognate_vs_control:noise1	0.905
## conditioncontrol_vs_fc_control:noise1	1.386
## conditiontrue_vs_false_cognate:noise1	0.679
## conditioncognate_vs_control:ctr(english)	-0.569
## conditioncontrol_vs_fc_control:ctr(english)	0.394
## conditiontrue_vs_false_cognate:ctr(english)	-1.392
## noise1:ctr(english)	0.107
## conditioncognate_vs_control:ctr(spanish)	1.762
## conditioncontrol_vs_fc_control:ctr(spanish)	2.003
## conditiontrue_vs_false_cognate:ctr(spanish)	2.450
## noise1:ctr(spanish)	-0.614
## ctr(english):ctr(spanish)	-1.184
## conditioncognate_vs_control:ctr(1/freq_per_million)	-0.139
## conditioncontrol_vs_fc_control:ctr(1/freq_per_million)	-1.063
## conditiontrue_vs_false_cognate:ctr(1/freq_per_million)	0.906
## noise1:ctr(1/freq_per_million)	0.603
## ctr(english):ctr(1/freq_per_million)	-0.774
## ctr(spanish):ctr(1/freq_per_million)	1.200
## conditioncognate_vs_control:noise1:ctr(english)	-1.235
## conditioncontrol_vs_fc_control:noise1:ctr(english)	-2.554
## conditiontrue_vs_false_cognate:noise1:ctr(english)	-0.988
## conditioncognate_vs_control:noise1:ctr(spanish)	0.805
## conditioncontrol_vs_fc_control:noise1:ctr(spanish)	1.758
## conditiontrue_vs_false_cognate:noise1:ctr(spanish)	1.348
## conditioncognate_vs_control:ctr(english):ctr(spanish)	0.771
## conditioncontrol_vs_fc_control:ctr(english):ctr(spanish)	-0.020
## conditiontrue_vs_false_cognate:ctr(english):ctr(spanish)	-0.295
## noise1:ctr(english):ctr(spanish)	-1.073
## conditioncognate_vs_control:noise1:ctr(1/freq_per_million)	0.423

```

## conditioncontrol_vs_fc_control:noise1:ctr(1/freq_per_million) -0.229
## conditiontrue_vs_false_cognate:noise1:ctr(1/freq_per_million) 1.308
## conditioncognate_vs_control:ctr(english):ctr(1/freq_per_million) 1.008
## conditioncontrol_vs_fc_control:ctr(english):ctr(1/freq_per_million) 0.283
## conditiontrue_vs_false_cognate:ctr(english):ctr(1/freq_per_million) -0.832
## noise1:ctr(english):ctr(1/freq_per_million) -1.260
## conditioncognate_vs_control:ctr(spanish):ctr(1/freq_per_million) -2.429
## conditioncontrol_vs_fc_control:ctr(spanish):ctr(1/freq_per_million) 0.743
## conditiontrue_vs_false_cognate:ctr(spanish):ctr(1/freq_per_million) 1.241
## noise1:ctr(spanish):ctr(1/freq_per_million) -0.500
## ctr(english):ctr(spanish):ctr(1/freq_per_million) -2.040
## conditioncognate_vs_control:noise1:ctr(english):ctr(spanish) 0.315
## conditioncontrol_vs_fc_control:noise1:ctr(english):ctr(spanish) 0.532
## conditiontrue_vs_false_cognate:noise1:ctr(english):ctr(spanish) 0.885
## conditioncognate_vs_control:noise1:ctr(english):ctr(1/freq_per_million) -0.878
## conditioncontrol_vs_fc_control:noise1:ctr(english):ctr(1/freq_per_million) 1.731
## conditiontrue_vs_false_cognate:noise1:ctr(english):ctr(1/freq_per_million) 0.081
## conditioncognate_vs_control:noise1:ctr(spanish):ctr(1/freq_per_million) 0.585
## conditioncontrol_vs_fc_control:noise1:ctr(spanish):ctr(1/freq_per_million) 2.104
## conditiontrue_vs_false_cognate:noise1:ctr(spanish):ctr(1/freq_per_million) 3.311
## conditioncognate_vs_control:ctr(english):ctr(spanish):ctr(1/freq_per_million) 0.998
## conditioncontrol_vs_fc_control:ctr(english):ctr(spanish):ctr(1/freq_per_million) 1.286
## conditiontrue_vs_false_cognate:ctr(english):ctr(spanish):ctr(1/freq_per_million) -0.188
## noise1:ctr(english):ctr(spanish):ctr(1/freq_per_million) -2.189
## conditioncognate_vs_control:noise1:ctr(english):ctr(spanish):ctr(1/freq_per_million) 0.255
## conditioncontrol_vs_fc_control:noise1:ctr(english):ctr(spanish):ctr(1/freq_per_million) 2.521
## conditiontrue_vs_false_cognate:noise1:ctr(english):ctr(spanish):ctr(1/freq_per_million) 0.678

##
## Correlation matrix not shown by default, as p = 64 > 12.
## Use print(x, correlation=TRUE) or
##     vcov(x)         if you need it

## Warning: Some predictor variables are on very different scales: consider
## rescaling

## Linear mixed model fit by REML ['lmerMod']
## Formula:
## R2 ~ condition * noise * ctr(english) * ctr(spanish) + ctr(freq_per_million) +
##     (1 | subj) + (1 | item)
## Data: GD
##
## REML criterion at convergence: 31793.2
##
## Scaled residuals:
##     Min       1Q   Median       3Q      Max
## -2.8692 -0.5964 -0.1462  0.4097  6.2408
##
## Random effects:
## Groups   Name                Variance Std.Dev.
## item     (Intercept)         4747     68.90
## subj     (Intercept)         8682     93.18
## Residual                            36855    191.98

```



```

## Number of obs: 2388, groups: item, 100; subj, 41
##
## Fixed effects:
##
## (Intercept) Estimate
## conditioncognate_vs_control 59.9965
## conditioncontrol_vs_fc_control 37.9799
## conditiontrue_vs_false_cognate 21.1568
## noise1 36.6007
## ctr(english) -311.0926
## ctr(spanish) 14.9371
## ctr(freq_per_million) -0.1502
## conditioncognate_vs_control:noise1 11.5368
## conditioncontrol_vs_fc_control:noise1 26.9397
## conditiontrue_vs_false_cognate:noise1 8.5777
## conditioncognate_vs_control:ctr(english) -155.7500
## conditioncontrol_vs_fc_control:ctr(english) -78.4161
## conditiontrue_vs_false_cognate:ctr(english) -50.3587
## noise1:ctr(english) -46.4503
## conditioncognate_vs_control:ctr(spanish) 125.7545
## conditioncontrol_vs_fc_control:ctr(spanish) 12.5661
## conditiontrue_vs_false_cognate:ctr(spanish) -15.0704
## noise1:ctr(spanish) -34.7790
## ctr(english):ctr(spanish) -703.1123
## conditioncognate_vs_control:noise1:ctr(english) -47.1001
## conditioncontrol_vs_fc_control:noise1:ctr(english) -87.3141
## conditiontrue_vs_false_cognate:noise1:ctr(english) 2.2260
## conditioncognate_vs_control:noise1:ctr(spanish) 38.5651
## conditioncontrol_vs_fc_control:noise1:ctr(spanish) 7.1241
## conditiontrue_vs_false_cognate:noise1:ctr(spanish) 2.6234
## conditioncognate_vs_control:ctr(english):ctr(spanish) -570.0240
## conditioncontrol_vs_fc_control:ctr(english):ctr(spanish) -479.9814
## conditiontrue_vs_false_cognate:ctr(english):ctr(spanish) -191.0036
## noise1:ctr(english):ctr(spanish) -56.4713
## conditioncognate_vs_control:noise1:ctr(english):ctr(spanish) -663.3456
## conditioncontrol_vs_fc_control:noise1:ctr(english):ctr(spanish) -185.1406
## conditiontrue_vs_false_cognate:noise1:ctr(english):ctr(spanish) -213.1623
## Std. Error
## (Intercept) 17.7371
## conditioncognate_vs_control 12.6217
## conditioncontrol_vs_fc_control 18.6871
## conditiontrue_vs_false_cognate 8.7950
## noise1 4.4146
## ctr(english) 90.5720
## ctr(spanish) 109.4158
## ctr(freq_per_million) 0.1067
## conditioncognate_vs_control:noise1 12.6028
## conditioncontrol_vs_fc_control:noise1 12.2916
## conditiontrue_vs_false_cognate:noise1 8.7913
## conditioncognate_vs_control:ctr(english) 68.6161
## conditioncontrol_vs_fc_control:ctr(english) 68.7555
## conditiontrue_vs_false_cognate:ctr(english) 48.7840
## noise1:ctr(english) 24.9216
## conditioncognate_vs_control:ctr(spanish) 84.1376

```

```

## conditioncontrol_vs_fc_control:ctr(spanish) 83.1897
## conditiontrue_vs_false_cognate:ctr(spanish) 59.3292
## noise1:ctr(spanish) 30.0755
## ctr(english):ctr(spanish) 461.4566
## conditioncognate_vs_control:noise1:ctr(english) 70.2968
## conditioncontrol_vs_fc_control:noise1:ctr(english) 69.3945
## conditiontrue_vs_false_cognate:noise1:ctr(english) 49.8136
## conditioncognate_vs_control:noise1:ctr(spanish) 84.7249
## conditioncontrol_vs_fc_control:noise1:ctr(spanish) 83.7137
## conditiontrue_vs_false_cognate:noise1:ctr(spanish) 59.8749
## conditioncognate_vs_control:ctr(english):ctr(spanish) 367.8430
## conditioncontrol_vs_fc_control:ctr(english):ctr(spanish) 362.3670
## conditiontrue_vs_false_cognate:ctr(english):ctr(spanish) 257.3981
## noise1:ctr(english):ctr(spanish) 124.7497
## conditioncognate_vs_control:noise1:ctr(english):ctr(spanish) 355.6587
## conditioncontrol_vs_fc_control:noise1:ctr(english):ctr(spanish) 355.7685
## conditiontrue_vs_false_cognate:noise1:ctr(english):ctr(spanish) 249.4138
## t value
## (Intercept) 22.061
## conditioncognate_vs_control 4.753
## conditioncontrol_vs_fc_control 2.032
## conditiontrue_vs_false_cognate 2.406
## noise1 8.291
## ctr(english) -3.435
## ctr(spanish) 0.137
## ctr(freq_per_million) -1.407
## conditioncognate_vs_control:noise1 0.915
## conditioncontrol_vs_fc_control:noise1 2.192
## conditiontrue_vs_false_cognate:noise1 0.976
## conditioncognate_vs_control:ctr(english) -2.270
## conditioncontrol_vs_fc_control:ctr(english) -1.141
## conditiontrue_vs_false_cognate:ctr(english) -1.032
## noise1:ctr(english) -1.864
## conditioncognate_vs_control:ctr(spanish) 1.495
## conditioncontrol_vs_fc_control:ctr(spanish) 0.151
## conditiontrue_vs_false_cognate:ctr(spanish) -0.254
## noise1:ctr(spanish) -1.156
## ctr(english):ctr(spanish) -1.524
## conditioncognate_vs_control:noise1:ctr(english) -0.670
## conditioncontrol_vs_fc_control:noise1:ctr(english) -1.258
## conditiontrue_vs_false_cognate:noise1:ctr(english) 0.045
## conditioncognate_vs_control:noise1:ctr(spanish) 0.455
## conditioncontrol_vs_fc_control:noise1:ctr(spanish) 0.085
## conditiontrue_vs_false_cognate:noise1:ctr(spanish) 0.044
## conditioncognate_vs_control:ctr(english):ctr(spanish) -1.550
## conditioncontrol_vs_fc_control:ctr(english):ctr(spanish) -1.325
## conditiontrue_vs_false_cognate:ctr(english):ctr(spanish) -0.742
## noise1:ctr(english):ctr(spanish) -0.453
## conditioncognate_vs_control:noise1:ctr(english):ctr(spanish) -1.865
## conditioncontrol_vs_fc_control:noise1:ctr(english):ctr(spanish) -0.520
## conditiontrue_vs_false_cognate:noise1:ctr(english):ctr(spanish) -0.855

```

```
##
```

```
## Correlation matrix not shown by default, as p = 33 > 12.
```

```

## Use print(x, correlation=TRUE) or
##     vcov(x)           if you need it

## fit warnings:
## Some predictor variables are on very different scales: consider rescaling

## Warning: Some predictor variables are on very different scales: consider
## rescaling

## Linear mixed model fit by REML ['lmerMod']
## Formula:
## R2 ~ condition * noise + ctr(english) * ctr(spanish) * ctr(freq_per_million) +
##     (1 | subj) + (1 | item)
## Data: TVT
##
## REML criterion at convergence: 43746
##
## Scaled residuals:
##      Min       1Q   Median       3Q      Max
## -2.4803 -0.5819 -0.1496  0.3632  8.3572
##
## Random effects:
## Groups Name Variance Std.Dev.
## item (Intercept) 31896 178.6
## subj (Intercept) 38125 195.3
## Residual 164385 405.4
## Number of obs: 2934, groups: item, 100; subj, 41
##
## Fixed effects:
##
## Estimate Std. Error
## (Intercept) 688.7006 38.6021
## conditioncognate_vs_control 148.0955 21.2793
## conditioncontrol_vs_fc_control -2.0254 41.6756
## conditiontrue_vs_false_cognate 47.3866 15.0713
## noise1 55.2730 7.5679
## ctr(english) -835.4790 187.6794
## ctr(spanish) 526.0176 227.2798
## ctr(freq_per_million) -0.8922 0.2572
## conditioncognate_vs_control:noise1 -16.3758 21.2906
## conditioncontrol_vs_fc_control:noise1 -4.8022 21.3126
## conditiontrue_vs_false_cognate:noise1 -5.7313 15.0971
## ctr(english):ctr(spanish) -2487.4494 968.5154
## ctr(english):ctr(freq_per_million) 2.0141 0.6510
## ctr(spanish):ctr(freq_per_million) -1.1830 0.8159
## ctr(english):ctr(spanish):ctr(freq_per_million) 7.1344 3.1550
##
## t value
## (Intercept) 17.841
## conditioncognate_vs_control 6.960
## conditioncontrol_vs_fc_control -0.049
## conditiontrue_vs_false_cognate 3.144
## noise1 7.304
## ctr(english) -4.452
## ctr(spanish) 2.314

```

```

## ctr(freq_per_million) -3.469
## conditioncognate_vs_control:noise1 -0.769
## conditioncontrol_vs_fc_control:noise1 -0.225
## conditiontrue_vs_false_cognate:noise1 -0.380
## ctr(english):ctr(spanish) -2.568
## ctr(english):ctr(freq_per_million) 3.094
## ctr(spanish):ctr(freq_per_million) -1.450
## ctr(english):ctr(spanish):ctr(freq_per_million) 2.261

##
## Correlation matrix not shown by default, as p = 15 > 12.
## Use print(x, correlation=TRUE) or
##      vcov(x)      if you need it

## fit warnings:
## Some predictor variables are on very different scales: consider rescaling

```