Tools for Teaching
Quantitative Thinking

Spotting white lies - GLM & MM

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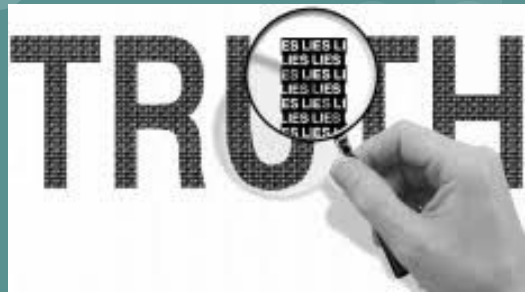
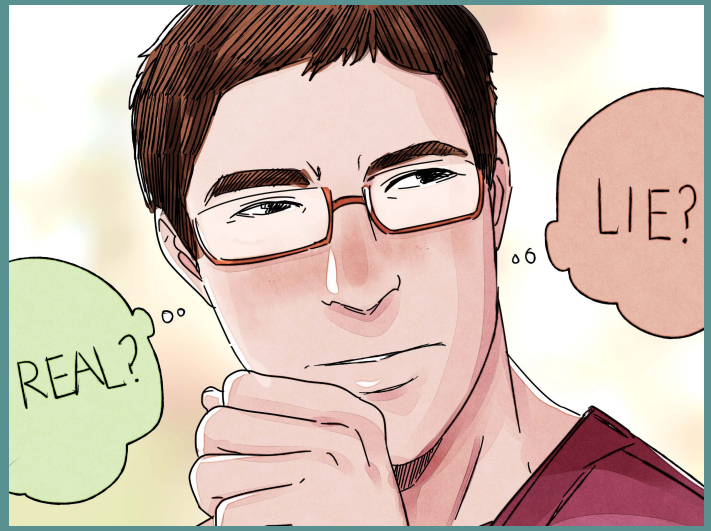


Experiment Design

- 39 participants
- 56 different video clips
- decide true or false
    - Two categories of topic, food or music
    - Actors made the video clips
    - They were asked which category they preferred before hand
    - Then actors were asked to tell truth or lie about their preference in each video clip



	subj	clipn	dv	resp	clipt	clipf	clipcat	actor	ees
1	1	8	0	0	1	1	1	1	69
2	1	11	1	1	1	1	1	4	74

- clipn = Serial number of video clips
- dv = Outcome variable (correct or false guess)
- resp = Participant's guess
- clipt = Actor's statement was a truth or a lie
- clipf = Actor is talking about favorite or least favorite category
- clipcat = Category is food or music
- actor = One of seven actors
- ees = Actors' expressiveness rated by participants

Research questions

- Category: Are people more accurate at detecting lies when the category is food or music?
- Preference: Are people more accurate at detecting lies when actors are talking about their favorite category or least favorite category?
- Truthfulness: Are people more accurate at detecting lies when the statement in the clip is true?
- Expressiveness: Are people more accurate at detecting lies when the actor is more expressive?
- Actor: Are people more accurate at detecting the lies of a particular actor?

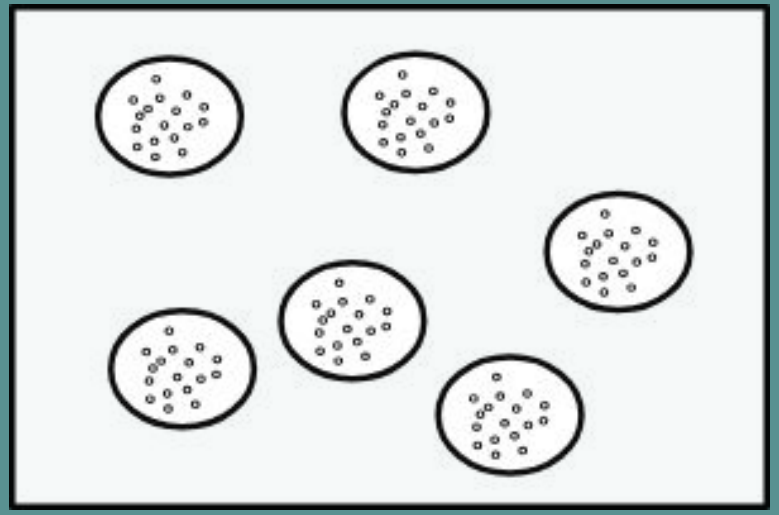
Fitting General Linear Logistic Models

```
Start:  AIC=2890.88
dv ~ clipt + clipf + clipcat + actor + ees.c


Step:  AIC=2890.88
dv ~ clipt + clipf + clipcat + actor

           Df Deviance    AIC
- clipt     1   2871.6 2889.6
<none>           2870.9 2890.9
- clipcat   1   2882.5 2900.5
- clipf     1   2889.3 2907.3
- actor     6   2905.8 2913.8

Step:  AIC=2889.59
dv ~ clipf + clipcat + actor

           Df Deviance    AIC
<none>           2871.6 2889.6
+ clipt     1   2870.9 2890.9
- clipcat   1   2883.2 2899.2
- clipf     1   2890.0 2906.0
- actor     6   2906.5 2912.5
```

- Started with generalized linear logistic models
- Considered all possible combinations of predictors using stepAIC function
- AIC measures relative statistical quality of models
- Model with lowest AIC: dv~clipf+clipcat+actor

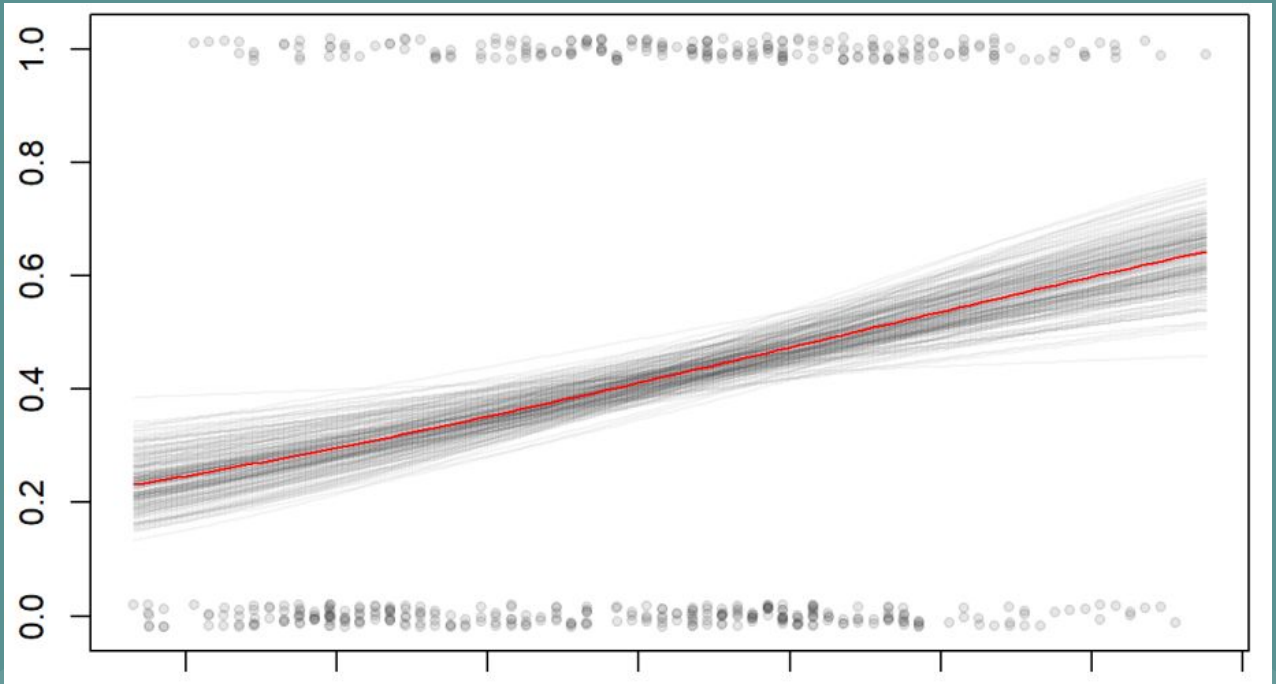
However...nested data

- Multiple measurements per subject = NOT independent
- Clips clustered by subject
- Clips grouped by actors
- Other examples:
  - Students in classrooms
  - Patients seen by same doctor
- How to deal with nested data?
  - Aggregate? No
  - Individual regressions? No
  - Mixed models? Yes!



https://stats.idre.ucla.edu/other/mult-pkg/introduction-to-linear-mixed-models/

Mixed Effect Models are Needed



What are mixed models?

- Extension of simple linear models
- Used when data is not independent
- Allows both fixed and random effects
  - Fixed effect: parameter that does not vary
  - Random effect: parameters that are themselves random variables
- Logistic mixed models: estimate odds that an event will occur in nested data

https://stats.idre.ucla.edu/other/mult-pkg/introduction-to-linear-mixed-models/

GLM and Mixed Effect Models

GLM

Accuracy ~ intercept + slope * fixed effect + error

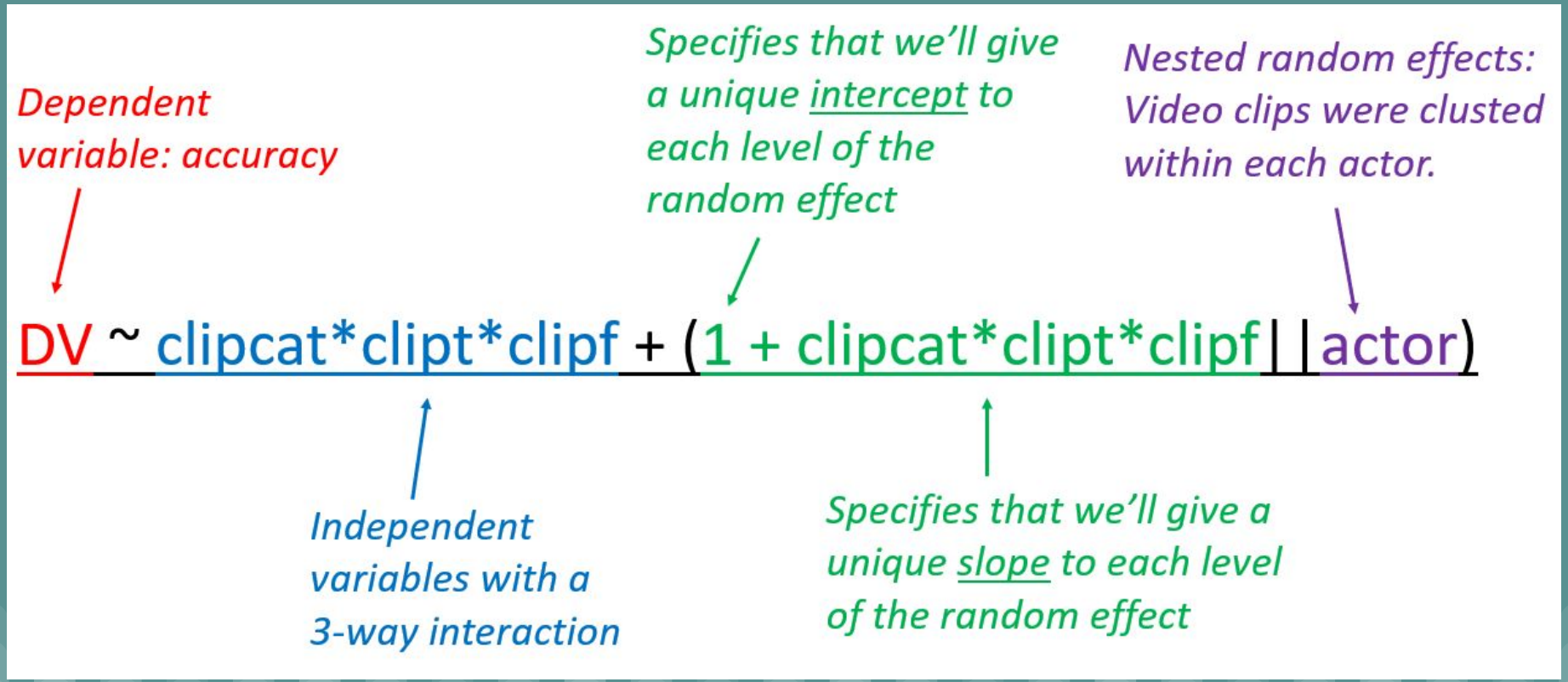
systematic part | random part

MM

Accuracy ~ intercept + slope * fixed effect + error

systematic part | random effects | residual error

Mixed Effect Models in R



Modelling the data

	Fixed effects	Random effects	AIC
Model 1	clipcat * clipt * clipf	1 + clipcat * clipt * clipf || subj	2888.9
Model 2	clipcat * clipt * clipf	1 + clipcat * clipt * clipf || actor	2836.5
Model 3	clipcat * clipt * clipf	1 + clipcat * clipt * clipf || clipn	2876

clipcat = category: food vs. music
clipt = statement truthfulness: true vs. false
clipf = preference: favorite vs. least favorite

Summary of the Model

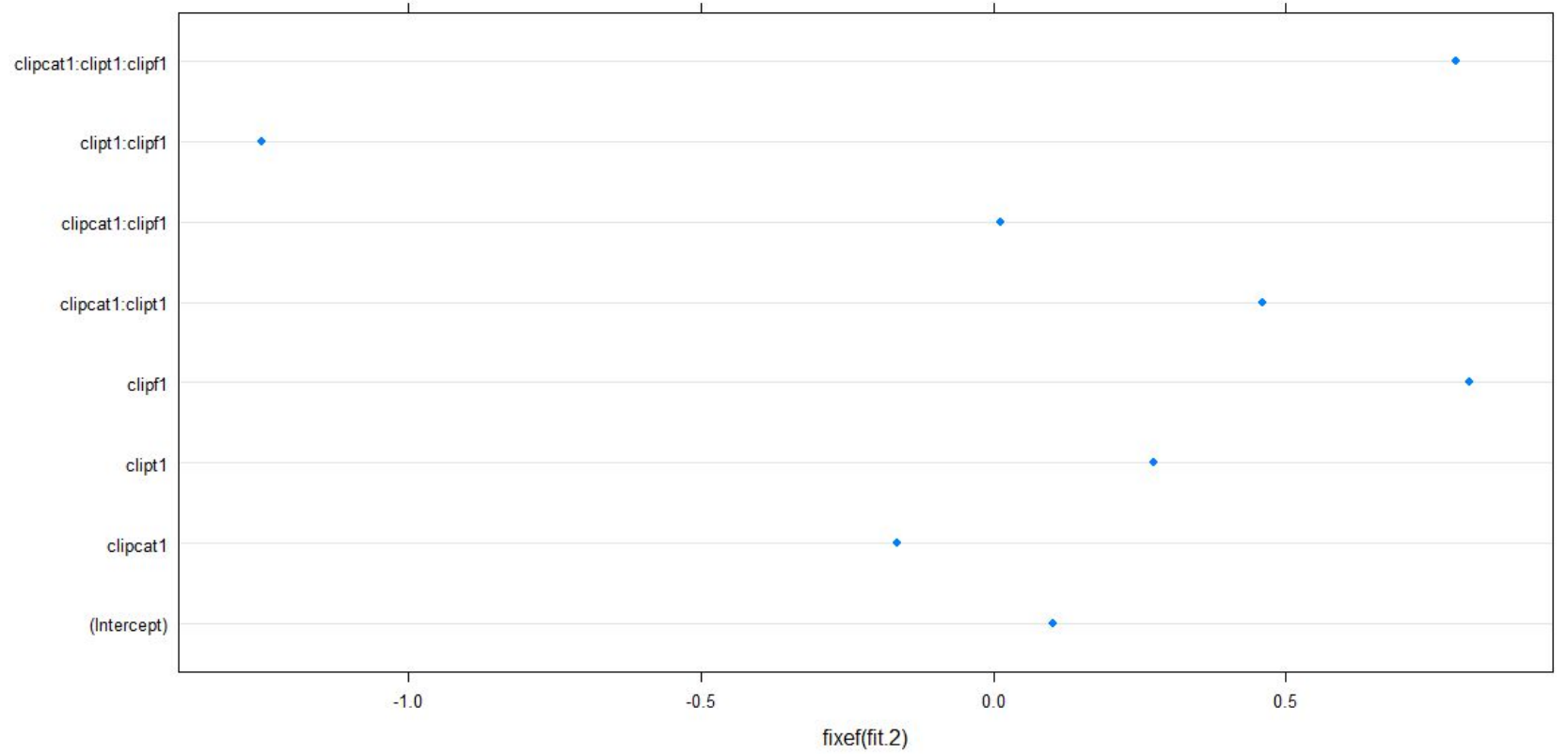
```
Generalized linear mixed model fit by maximum likelihood (Laplace Approximation) ['glmerMod']
 Family: binomial  ( logit )
Formula: dv ~ clipcat * clipt * clipf + (1 + clipcat * clipt * clipf ||      actor)
   Data: DATA
      AIC       BIC    logLik  deviance  df.resid
 2836.516  3314.385 -1334.258  2668.516      2100
```

```
Fixed effects:
                      Estimate Std. Error z value Pr(>|z|)
(Intercept)            0.10095    0.42231   0.239   0.8111
clipcat1              -0.16474    0.45507  -0.362   0.7173
clipt1                 0.27447    0.49376   0.556   0.5783
clipf1                 0.81266    0.43588   1.864   0.0623
clipcat1:clipt1        0.45974    0.70328   0.654   0.5133
clipcat1:clipf1        0.01306    0.56377   0.023   0.9815
clipt1:clipf1         -1.24970    0.71383  -1.751   0.0800
clipcat1:clipt1:clipf1 0.79154    0.79615   0.994   0.3201
```

```
Random effects:
 Groups  Name                      Std.Dev.  Corr
 actor   (Intercept)               0.000e+00
 actor.1 clipcat0                  1.022e-06
         clipcat1                  3.499e-06 -1.00
 actor.2 clipt0                    0.000e+00
         clipt1                    2.780e-08  NaN
 actor.3 clipf0                    2.468e-04
         clipf1                    4.648e-05 -1.00
 actor.4 clipcat0:clipt0           1.991e-01
         clipcat1:clipt0           4.562e-02  1.00
         clipcat0:clipt1           1.149e-01 -1.00 -1.00
         clipcat1:clipt1           1.587e-01 -1.00 -1.00  1.00
 actor.5 clipcat0:clipf0           1.742e-01
         clipcat1:clipf0           1.742e-02 -1.00
         clipcat0:clipf1           4.922e-02 -1.00  1.00
         clipcat1:clipf1           2.562e-03 -1.00  1.00  1.00
 actor.6 clipt0:clipf0             1.647e-01
         clipt1:clipf0             2.213e-01  1.00
         clipt0:clipf1             4.237e-02 -1.00 -1.00
         clipt1:clipf1             2.730e-02 -1.00 -1.00  1.00
 actor.7 clipcat0:clipt0:clipf0    1.007e+00
         clipcat1:clipt0:clipf0    7.881e-01  0.32
         clipcat0:clipt1:clipf0    9.565e-01  0.31  0.41
         clipcat1:clipt1:clipf0    4.429e-01  0.32  0.24 -0.66
         clipcat0:clipt0:clipf1    7.238e-01  0.40  0.95  0.31  0.30
         clipcat1:clipt0:clipf1    4.835e-01  0.40  0.73  0.59 -0.14  0.83
         clipcat0:clipt1:clipf1    7.459e-01 -0.68 -0.76 -0.62 -0.02 -0.85 -0.93
         clipcat1:clipt1:clipf1    4.471e-01 -0.08 -0.80 -0.49  0.01 -0.59 -0.31  0.39
Number of obs: 2184, groups:  actor, 7
```

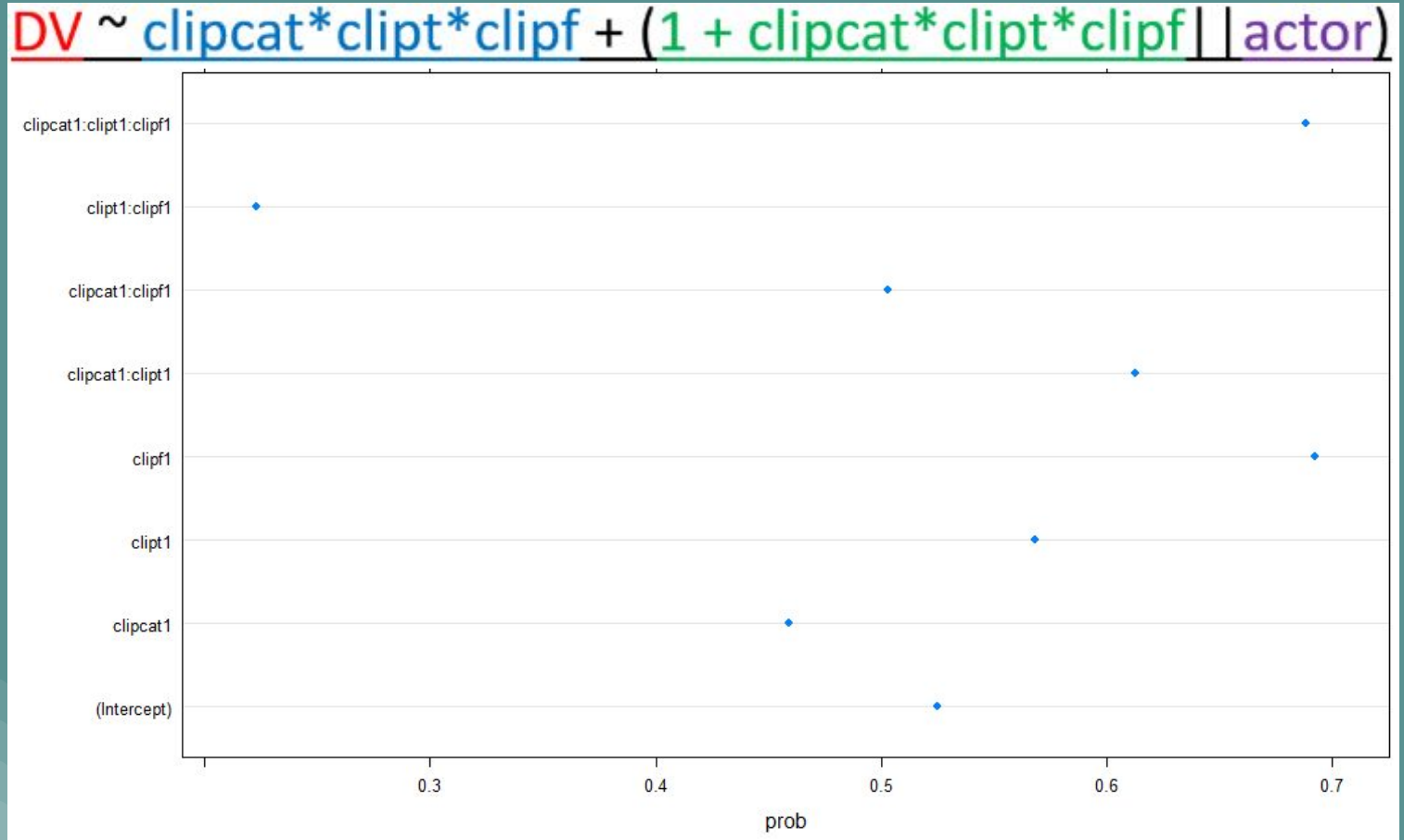
Results: Fixed Effects

DV ~ clipcat*clipt*clipf + (1 + clipcat*clipt*clipf || actor)



Results: Fixed Effects

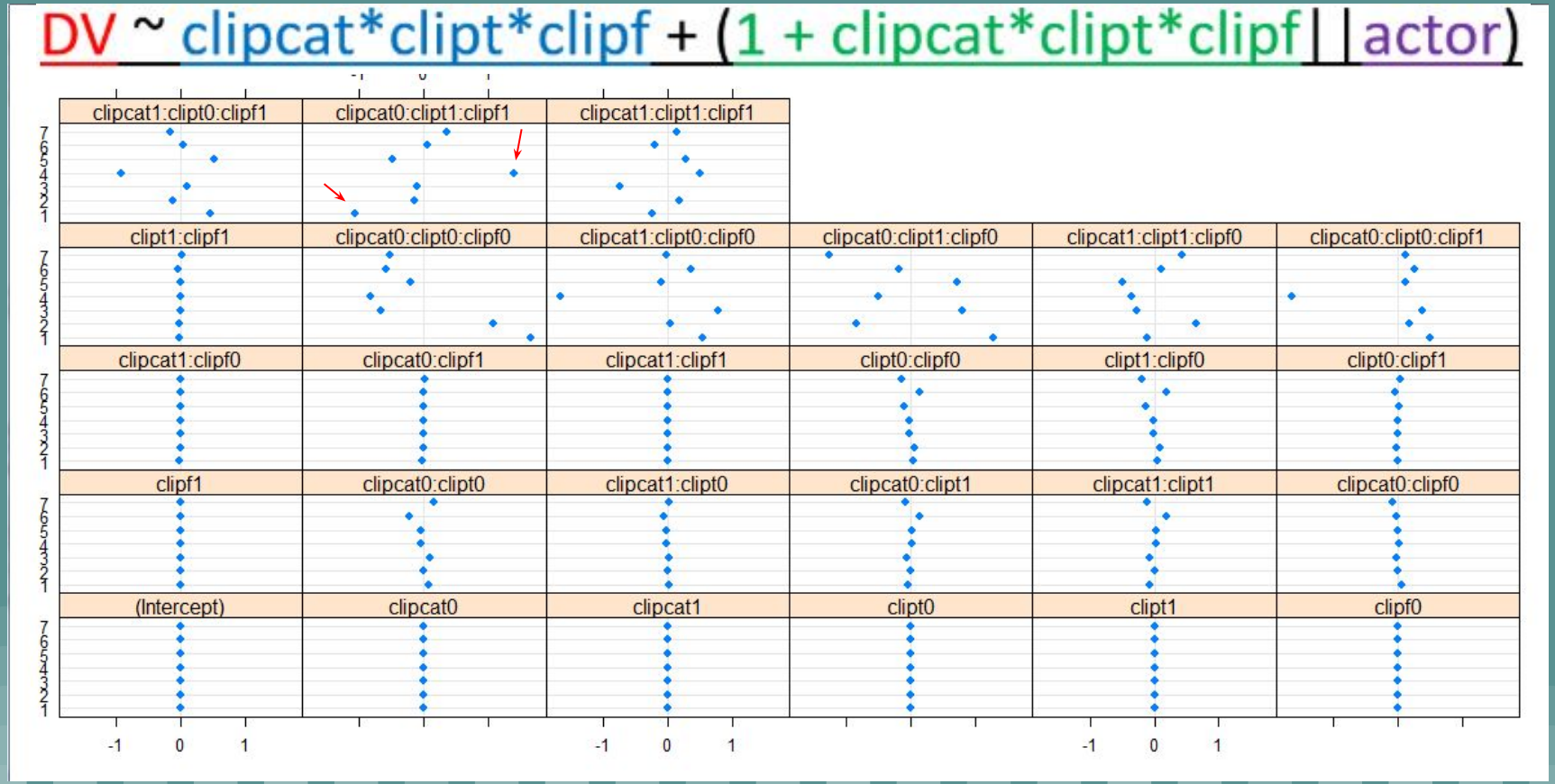
DV ~ clipcat*clipt*clipf + (1 + clipcat*clipt*clipf || actor)



Fixed Effects

- Overall, participants perform at chance level
- Highest accuracy when actors were talking about their favorite category (clipf=1)
- Higher accuracy when actors were saying a truthful statement about their favorite category and when the category was food (Clipcat1:clipt1:clipf1)
- Lower accuracy when actors were saying something truthful about their favorite category (clipt1:clipf1) and both categories (food and music) are included
- No effect was statistically significant

Results: Random Effects



General Conclusion

The influence of clip properties depends on each other (interaction), and these interaction effects vary within actors

Discussion

- Individual differences in detecting lies?
  Maybe not...
- Random effects within subjects didn’t explain much more variance of accuracy compared with random effects within actors
- People who tell lies (actors) matter!