# Conservativity, Distraction or Bi-conditional?

## QUANTIFIER INTERPRETATION IN DUTCH

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# Quantifier interpretation in Dutch

- Paper by Anna de Koster, Petra Hendriks, Bart Hollebrandse and Jennifer Spenader (in press)

- "Conservativity, Distraction or the Bi-conditional?: An investigation into children's errors with *only* and *all*"

- First ones to test this in Dutch with children

# Quantifiers in Dutch

- *All*: *Alle*
- *Only*: *Alleen*          (*enkel*)

- Whereas *all* is conservative, *only* is not

# Conservativity

- All bears are furry

- Set A: set of bears
- Set B: things that are furry

- Conversative: We only have to consider the intersection between Set A and Set B
  - Thus, "fewer members have to be considered to determine the truth of a quantified sentence"

# Bi-conditional

- In short, *all* could be interpreted as *all-and-only*
- Overexhaustive response

- Example:
- "All children are riding an elephant"
- Incorrect rejection based on the riderless elephant
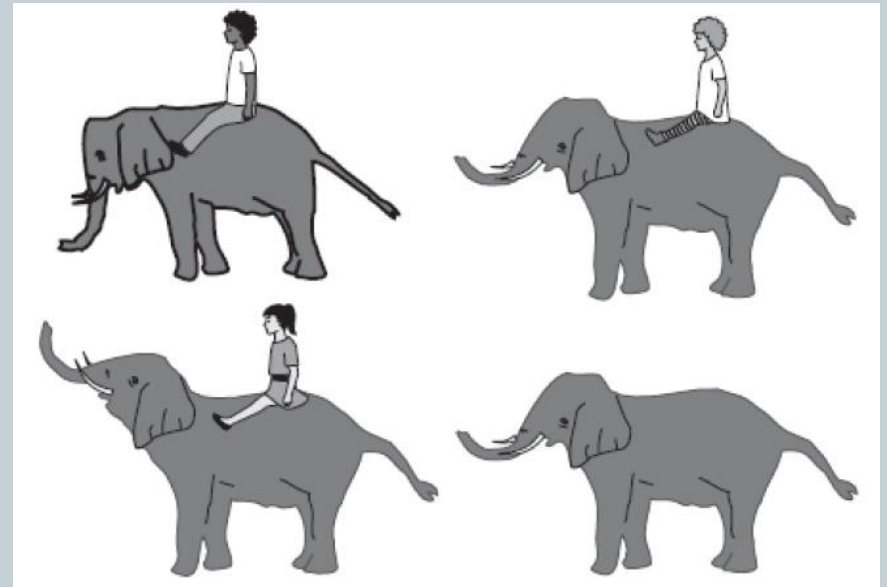
# Experiment 1 & 2

- Experiment 1: all the / only the → includes determiner
  - All the bunnies are dancing
- Experiment 2: all / only → excludes determiner
-    AND used fictional monsters instead of animals
  - All kroepies are dancing

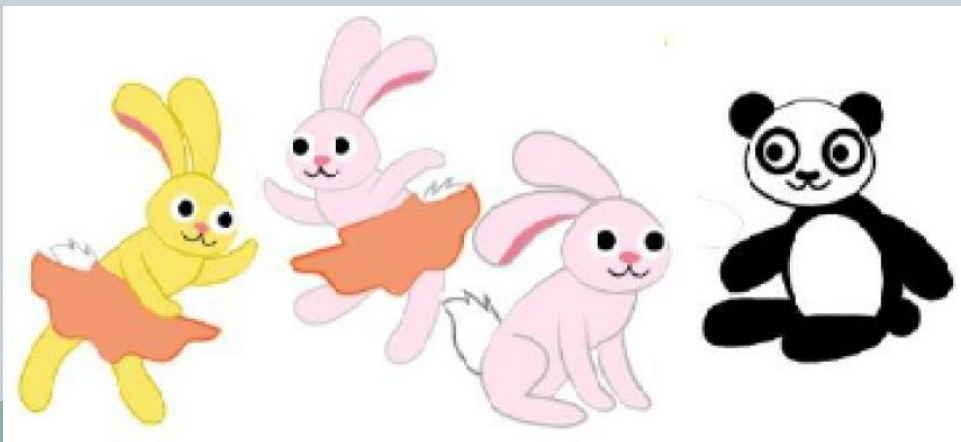- 2 x 2 design:
  - Picture
  - Quantifier

# Design: Pictures

- All-participant condition:



- Two non-participant condition:

# Experiment 2: Changes

- *Only* + Two non-participants condition was not completely neutral, could be interpreted to suggest that the entire set of bunnies had to dance in order to be true, which is not what was intended.

- Fictional monsters (e.g. kroepies) were used here instead to avoid real world interference ("Panda's can't ice skate")

# Expectations & Results

| Picture | Quantifier | Expectation |
|---------|-----------|-------------|
| All Participants | All | True |
| All Particpants | Only | False |
| Two non-participants | All | False |
| Two non-participants | Only | True |

| Picture | Quantifier | Result |
|---------|-----------|--------|
| All participants | All | Overexhaustive response |
| All participants | Only | Adult-like performance |
| Two non-participants | All | Overexhaustive response |
| Two non-participants | Only | Incorrect rejection |

# Experiment 3
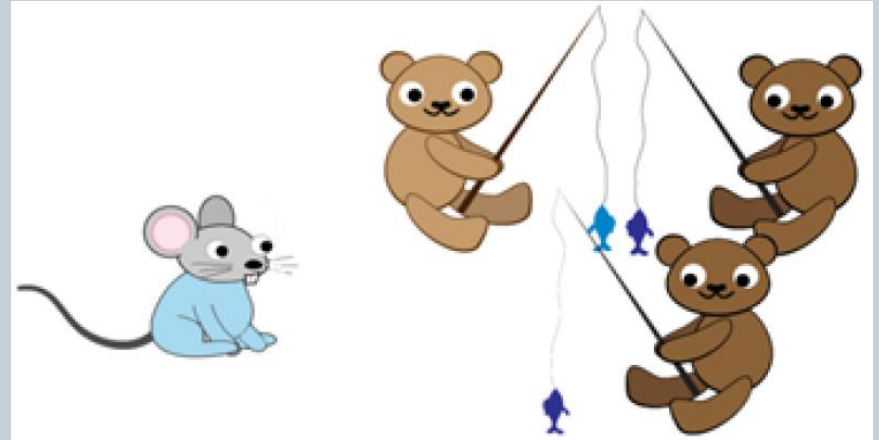
- Distraction caused by the additional characters in the pictures?
  - "All bunnies are dancing"
  - "No because this panda is also dancing"

- Bi-conditional (overexhaustive)?
  - "All bunnies are dancing" → All-and-only bunnies are dancing
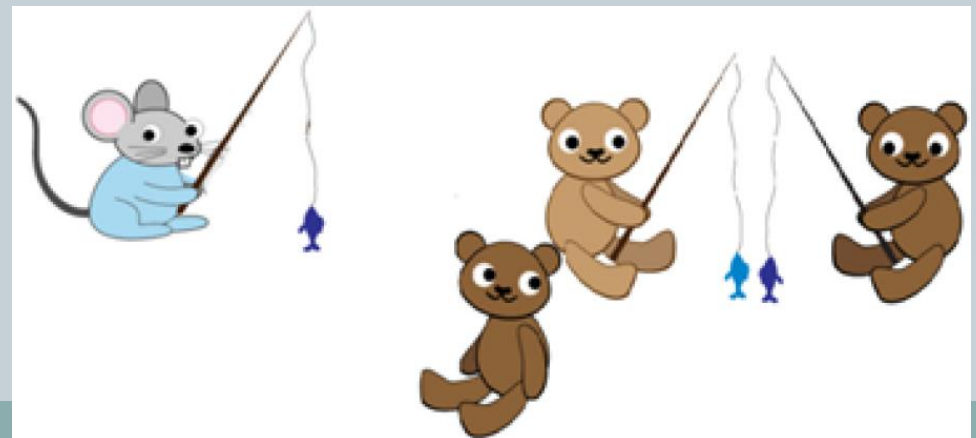  - "No because this panda is also dancing"

# Experiment 3

- Extra-character condition

- Non-participant condition:

# Expectations

| Extra character | Distraction? | Bi-conditional? |
| --- | --- | --- |
| All | False | True |
| Only | False | True |

| Non-participant | Distraction? | Bi-conditional? |
| --- | --- | --- |
| All | False | False |
| Only | False | False |

- Bi-conditional: *all-and-only*

# Statistics

- Mixed-effects regression
- Fixed factors: Quantifier, Picture
- Random factors: Item, Participant, Age

# First outcome

```
Linear mixed model fit by REML ['lmerMod']
Formula:
Answer ~ Picture + Sentence + (1 | Item) + (1 | Subject_Nr) +
    (1 | Age_Group)
    Data: dataset

REML criterion at convergence: 271.7

Scaled residuals:
    Min      1Q  Median      3Q     Max
-3.3224 -0.4826 -0.1298  0.3834  3.2232

Random effects:
 Groups      Name        Variance  Std.Dev.
 Subject_Nr (Intercept) 1.790e-02 1.338e-01
 Item       (Intercept) 3.555e-17 5.962e-09
 Age_Group  (Intercept) 0.000e+00 0.000e+00
 Residual               8.863e-02 2.977e-01
Number of obs: 512, groups:
Subject_Nr, 32; Item, 16; Age_Group, 2

Fixed effects:
              Estimate Std. Error t value
(Intercept)   0.191406   0.032843   5.828
Pictureplus   0.750000   0.026315  28.501
Sentencezalle -0.007813   0.026315  -0.297

Correlation of Fixed Effects:
            (Intr) Pctrpl
Pictureplus -0.401
Sentencezll -0.401  0.000
```

Note:
Picturemin=Non-participant
Pictureplus=Extra participant
Sentence=Quantifier
Subject_Nr=Participant

# Model 2: Interaction of Picture and Quantifier

```
Linear mixed model fit by REML ['lmerMod']
Formula: Answer ~ Picture * Sentence + (1 | Item) + (1 | Subject_Nr) +        (1 | Age_Group)
   Data: dataset

REML criterion at convergence: 275

Scaled residuals:
    Min      1Q  Median      3Q     Max
-3.3610 -0.4956 -0.1429  0.4226  3.1831

Random effects:
 Groups      Name        Variance Std.Dev.
 Subject_Nr (Intercept) 0.01790  0.1338
 Item       (Intercept) 0.00000  0.0000
 Age_Group  (Intercept) 0.00000  0.0000
 Residual               0.08867  0.2978
Number of obs: 512, groups:  Subject_Nr, 32; Item, 16; Age_Group, 2

Fixed effects:
                          Estimate Std. Error t value
(Intercept)                0.17969    0.03538   5.078
Pictureplus                0.77344    0.03722  20.779
Sentencezalle              0.01562    0.03722   0.420
Pictureplus:Sentencezalle -0.04687    0.05264  -0.890

Correlation of Fixed Effects:
            (Intr) Pctrpl Sntncz
Pictureplus -0.526
Sentencezll -0.526  0.500
Pctrpls:Snt  0.372 -0.707 -0.707
```

# Comparison

```
> anova(Model1,Model2)
refitting model(s) with ML (instead of REML)
Data: dataset
Models:
Model1: Answer ~ Picture + Sentence + (1 | Item) + (1 | Subject_Nr) +
Model1:         (1 | Age_Group)
Model2: Answer ~ Picture * Sentence + (1 | Item) + (1 | Subject_Nr) +
Model2:         (1 | Age_Group)
       Df     AIC    BIC  logLik deviance  Chisq Chi Df Pr(>Chisq)
Model1  7 269.43 299.10 -127.72   255.43
Model2  8 270.64 304.54 -127.32   254.64 0.7973      1     0.3719
```

Since the AIC of Model 1 is lower than that of Model 2, we continue with this model.

# Model 3

- Left out Participant → No improvement
- Left out Age → Better model + simpler!

```
> anova(Model1,Model3)
refitting model(s) with ML (instead of REML)
Data: dataset
Models:
Model3: Answer ~ Picture + Sentence + (1 | Item) + (1 | Subject_Nr)
Model1: Answer ~ Picture + Sentence + (1 | Item) + (1 | Subject_Nr) +
Model1:        (1 | Age_Group)
       Df     AIC     BIC   logLik deviance Chisq Chi Df
Model3  6 267.43 292.86 -127.72   255.43
Model1  7 269.43 299.10 -127.72   255.43      0       1
       Pr(>Chisq)
Model3
Model1             1
```

# Model 4

- Left out Item → Again better and simpler model!

```
> anova(Model3,Model4)
refitting model(s) with ML (instead of REML)
Data: dataset
Models:
Model4: Answer ~ Picture + Sentence + (1 | Subject_Nr)
Model3: Answer ~ Picture + Sentence + (1 | Item) + (1 | Subject_Nr)
       Df     AIC     BIC  logLik deviance Chisq Chi Df Pr(>Chisq)
Model4  5 265.43 286.62 -127.72    255.43
Model3  6 267.43 292.86 -127.72    255.43     0      1          1
```

# Model 5

- I also tried a model which left out either Picture or Quantifier (Sentence) as a predicting factor:
  - Leaving out Picture gave no improvement
  - Small improvement when leaving out Quantifier

- Even though there was a slightly lower AIC when leaving out the Quantifier as a factor, there was no improvement of at least 2, so not a better model than Model 4.

# Finally

- Model 4 is best:
- Response ~ Picture + Quantifier + (1|Participant)
  - Effect of both fixed factors Picture and Quantifier
  - As well as the random factor Participant

| Extra character | Distraction? | Bi-conditional |
|---|---|---|
| All | False | True |
| Only | False | True |

- Outcome:
- Children are affected by their interpretation of *all* and *only* on the basis of the bi-conditional and thus prefer overexhaustive responses which take into account the larger set (all furry things as well as all bears)