Binary Choice Analysis

Robert Hickman

22 February 2018

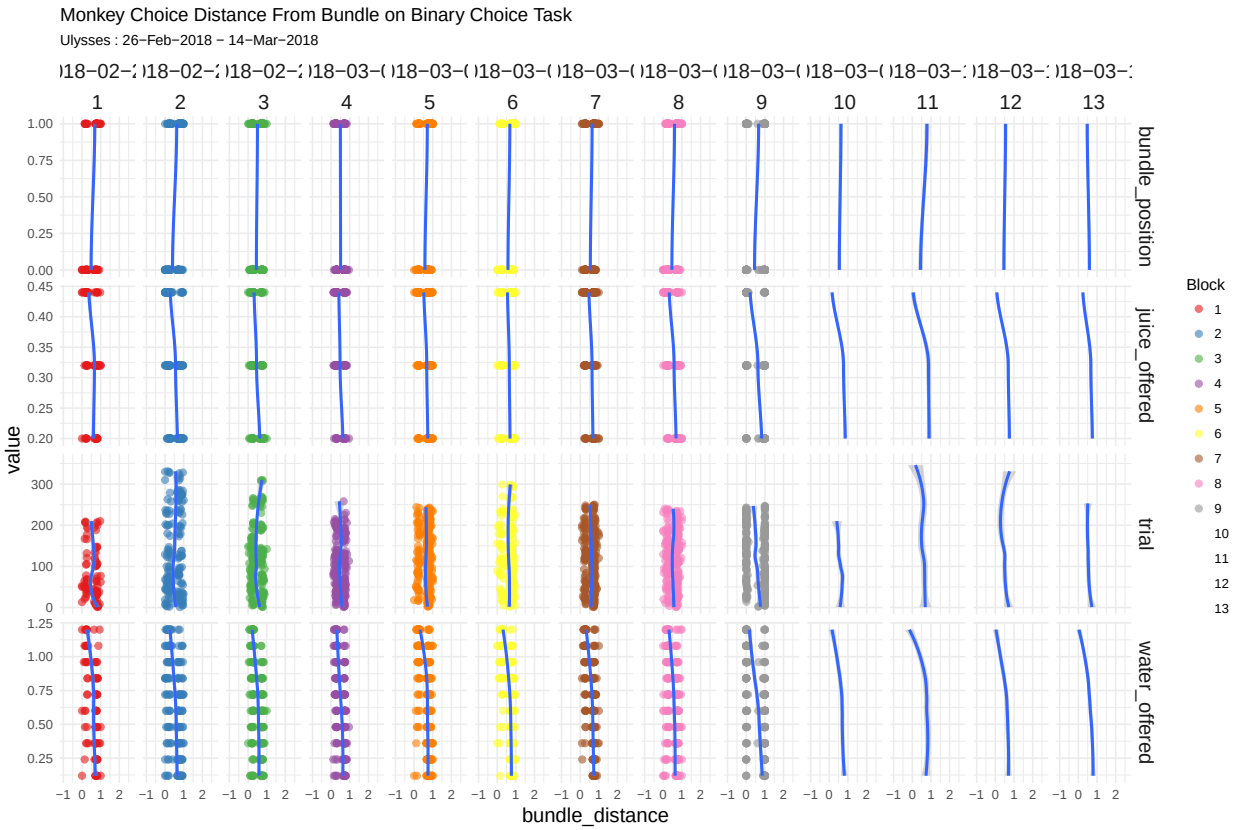
```
monkey <- "Ulysses"
today <- "14-Mar-2018"
look_back <- "26-Feb-2018"

start_trial <- 0
stop_trial <- "all"

merge_days <- TRUE
```

```
p1
```


```
p2
```




```
#generate a model of likelihood to choice for the fractal dependent on it's position,
#value and associated water
model <- glm(data = task_data,
             fractal_choice ~ bundle_position + water_offered + juice_offered + trial + date,
             family = "binomial")

#summarise the parameters
summary(model)
```

```
##
## Call:
## glm(formula = fractal_choice ~ bundle_position + water_offered +
##     juice_offered + trial + date, family = "binomial", data = task_data)
##
## Deviance Residuals:
##     Min       1Q   Median       3Q      Max
## -3.0767  -0.5825  -0.1714   0.5519   3.1278
##
## Coefficients:
##                   Estimate Std. Error z value Pr(>|z|)
## (Intercept)     -8.817e+01  1.979e+02  -0.446    0.656
## bundle_position -1.023e+00  1.151e-01  -8.891  < 2e-16 ***
## water_offered    5.063e+00  2.202e-01  22.993  < 2e-16 ***
## juice_offered    1.737e+01  7.623e-01  22.786  < 2e-16 ***
## trial            3.347e-03  7.284e-04   4.595 4.34e-06 ***
## date             4.465e-03  1.125e-02   0.397    0.691
## ---
```

```
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## (Dispersion parameter for binomial family taken to be 1)
##
##     Null deviance: 3565  on 2644  degrees of freedom
## Residual deviance: 2030  on 2639  degrees of freedom
##   (1129 observations deleted due to missingness)
## AIC: 2042
##
## Number of Fisher Scoring iterations: 6
```

```
#test for side bias with an exact binomial test
binom.test(c(nrow(task_data %>%
                    .[c(bundle_position != fractal_choice)]),
             nrow(task_data %>%
                    .[c(bundle_position == fractal_choice)])))
```

```
##
##  Exact binomial test
##
## data:  c(nrow(task_data %>% .[c(bundle_position != fractal_choice)]),     nrow(task_data %>% .[c(bun
## number of successes = 1481, number of trials = 2645, p-value =
## 7.676e-10
## alternative hypothesis: true probability of success is not equal to 0.5
## 95 percent confidence interval:
##  0.5407602 0.5789557
## sample estimates:
## probability of success
##              0.5599244
```

```
#generate a model of likelihood to choice for the fractal dependent on it's position,
#value and associated water
model <- glm(data = dplyr::filter(task_data, block_no == max(block_no)),
             fractal_choice ~ bundle_position + water_offered + as.factor(juice_offered) + trial + date
             family = "binomial")

#summarise the parameters
summary(model)
```

```
##
## Call:
## glm(formula = fractal_choice ~ bundle_position + water_offered +
##     as.factor(juice_offered) + trial + date, family = "binomial",
##     data = dplyr::filter(task_data, block_no == max(block_no)))
##
## Deviance Residuals:
##      Min        1Q    Median        3Q       Max
## -2.12661  -0.41591  -0.02862   0.27799   2.40763
##
## Coefficients: (1 not defined because of singularities)
##                                Estimate Std. Error z value Pr(>|z|)
## (Intercept)                  -11.657850   1.763320  -6.611 3.81e-11 ***
## bundle_position                2.317640   0.577181   4.015 5.93e-05 ***
## water_offered                  8.568024   1.315536   6.513 7.37e-11 ***
## as.factor(juice_offered)0.32   1.131911   0.572396   1.977    0.048 *
```

```
## as.factor(juice_offered)0.44   6.369143   1.017742   6.258 3.90e-10 ***
## trial                          0.014788   0.003632   4.071 4.68e-05 ***
## date                                NA         NA      NA       NA
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## (Dispersion parameter for binomial family taken to be 1)
##
##     Null deviance: 303.51  on 219  degrees of freedom
## Residual deviance: 122.50  on 214  degrees of freedom
##   (70 observations deleted due to missingness)
## AIC: 134.5
##
## Number of Fisher Scoring iterations: 7
```

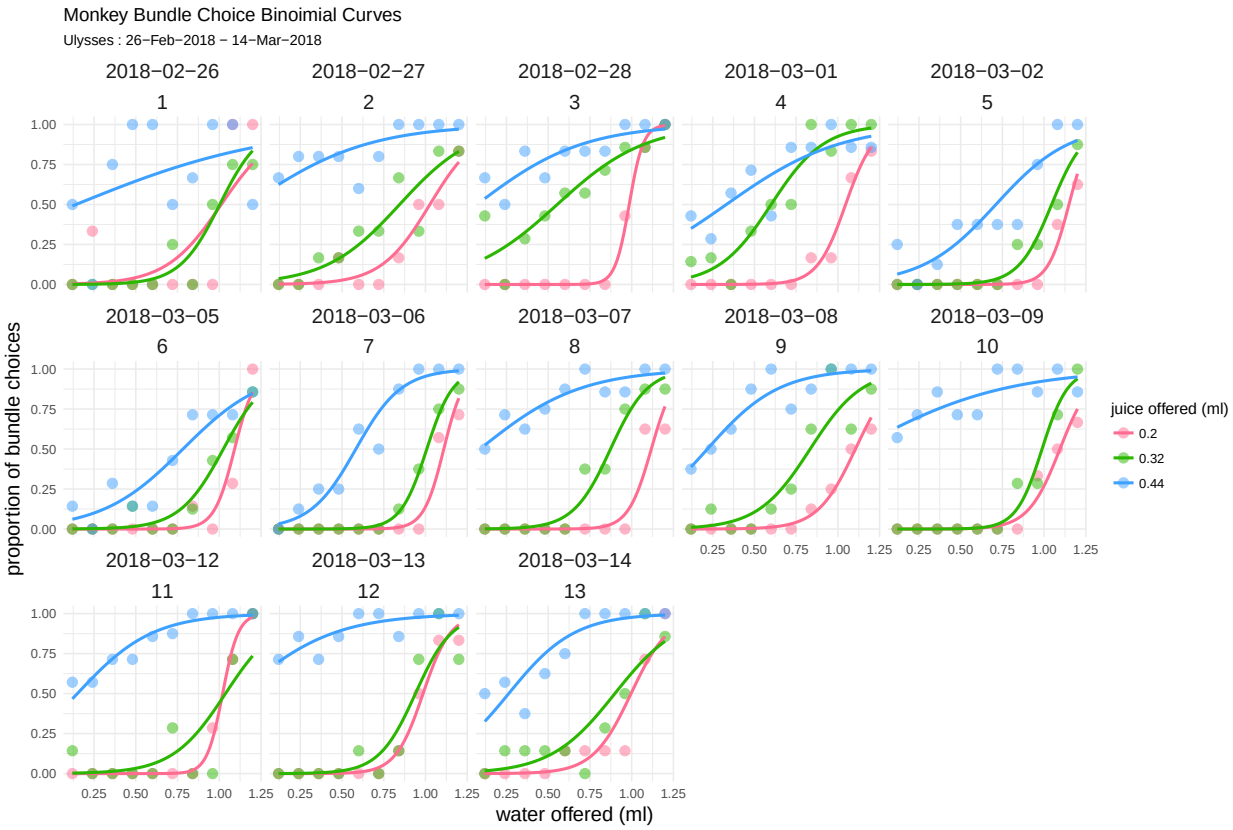
```
#test for side bias with an exact binomial test
binom.test(c(nrow(task_data %>%
                    .[c(bundle_position != fractal_choice & block_no == max(block_no))]),
             nrow(task_data %>%
                    .[c(bundle_position == fractal_choice & block_no == max(block_no))])))
```

```
##
##  Exact binomial test
##
## data:  c(nrow(task_data %>% .[c(bundle_position != fractal_choice &     block_no == max(block_no))])
## number of successes = 93, number of trials = 220, p-value =
## 0.02587
## alternative hypothesis: true probability of success is not equal to 0.5
## 95 percent confidence interval:
##  0.3566164 0.4909493
## sample estimates:
## probability of success
##              0.4227273
```

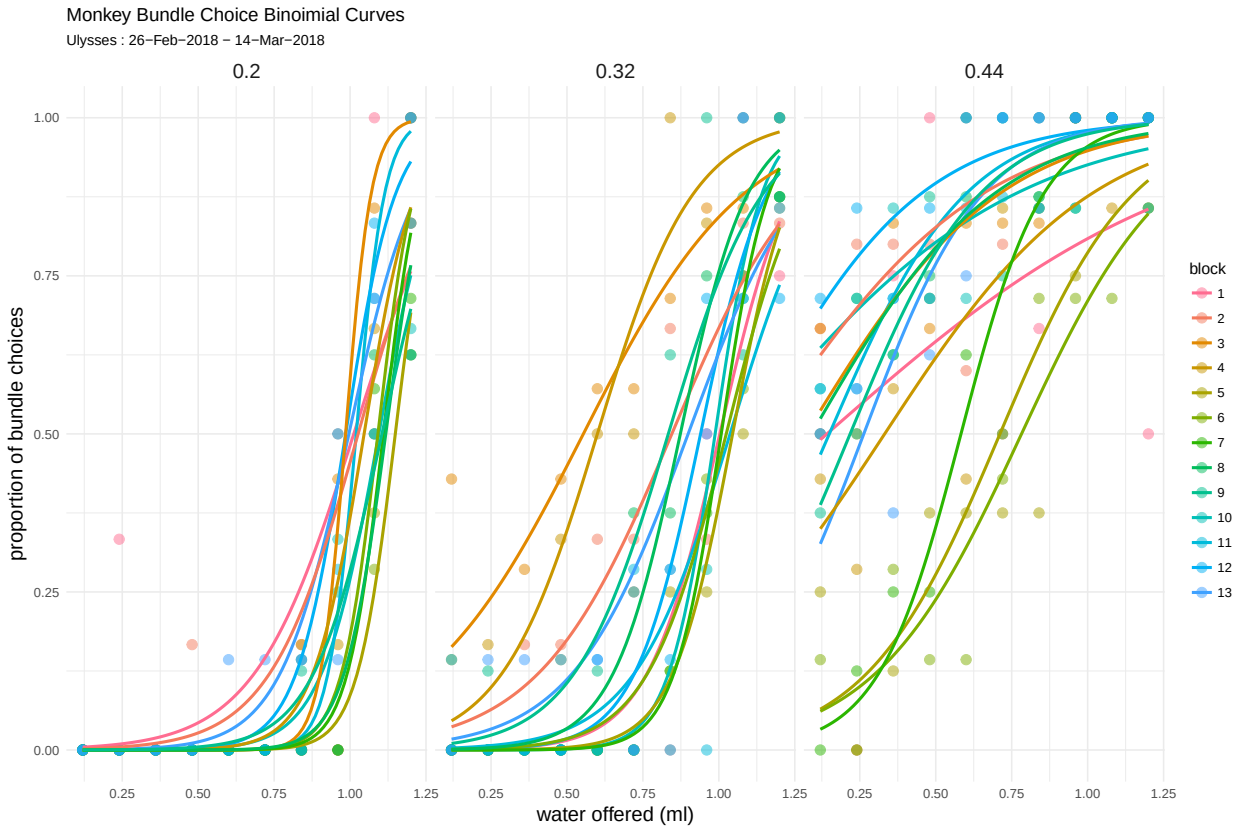
```
p3
```


Monkey Choice Failures
Ulysses : 26−Feb−2018 − 14−Mar−2018
2018−02−26
1
2018−02−27
2
2018−02−28
3
2018−03−01
4
2018−03−02
5
2018−03−05
6
2018−03−06
7
2018−03−07
8
2018−03−08
9
2018−03−09
10
2018−03−12
11
2018−03−13
12
2018−03−14
13
count
0
50
100
150
0.2
0.32
0.44
factor(juice_offered)
task_failure
joystick_not_stationary
no_bid
undefined
unfinished_bidding
NA

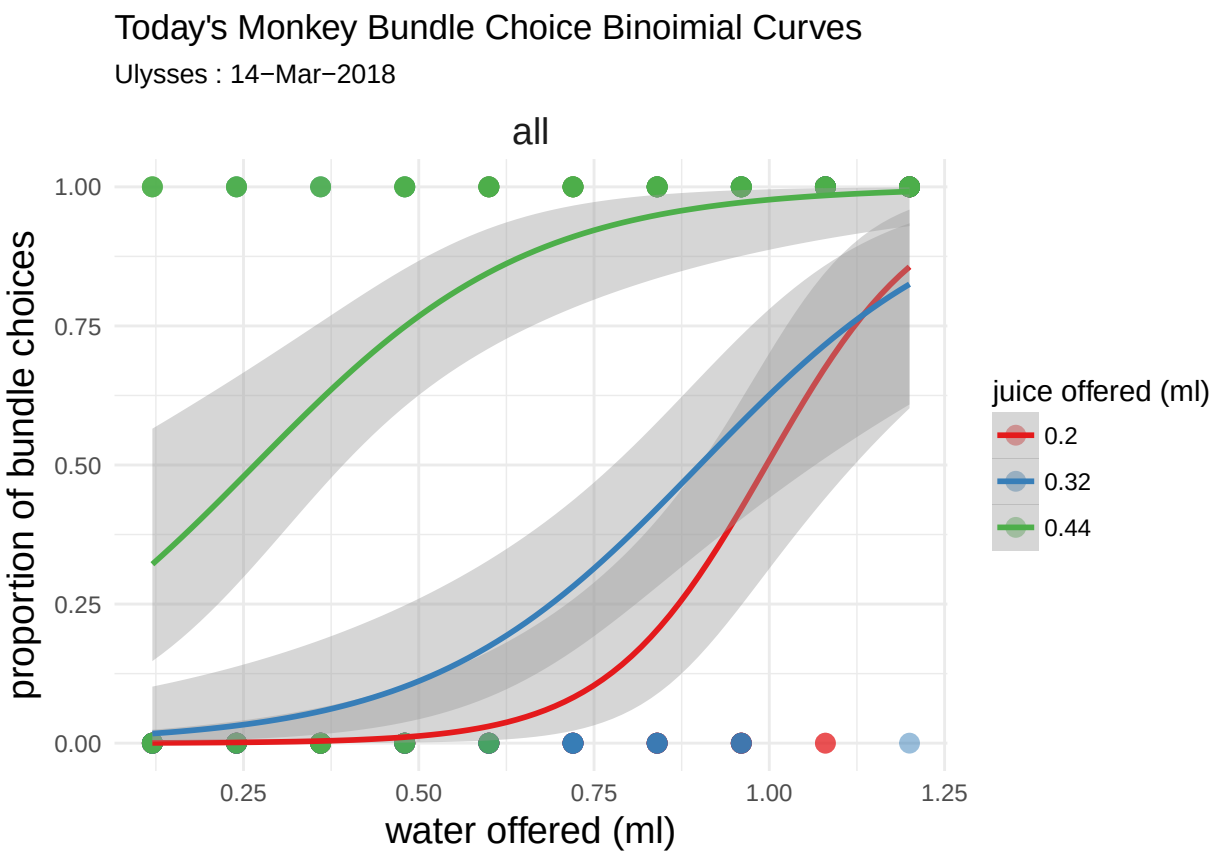
```
p4
```


Monkey Bundle Choice Binoimial Curves
Ulysses : 26−Feb−2018 − 14−Mar−2018
2018−02−26
1
2018−02−27
2
2018−02−28
3
2018−03−01
4
2018−03−02
5
2018−03−05
6
2018−03−06
7
2018−03−07
8
2018−03−08
9
2018−03−09
10
2018−03−12
11
2018−03−13
12
2018−03−14
13
proportion of bundle choices
water offered (ml)
juice offered (ml)
0.2
0.32
0.44

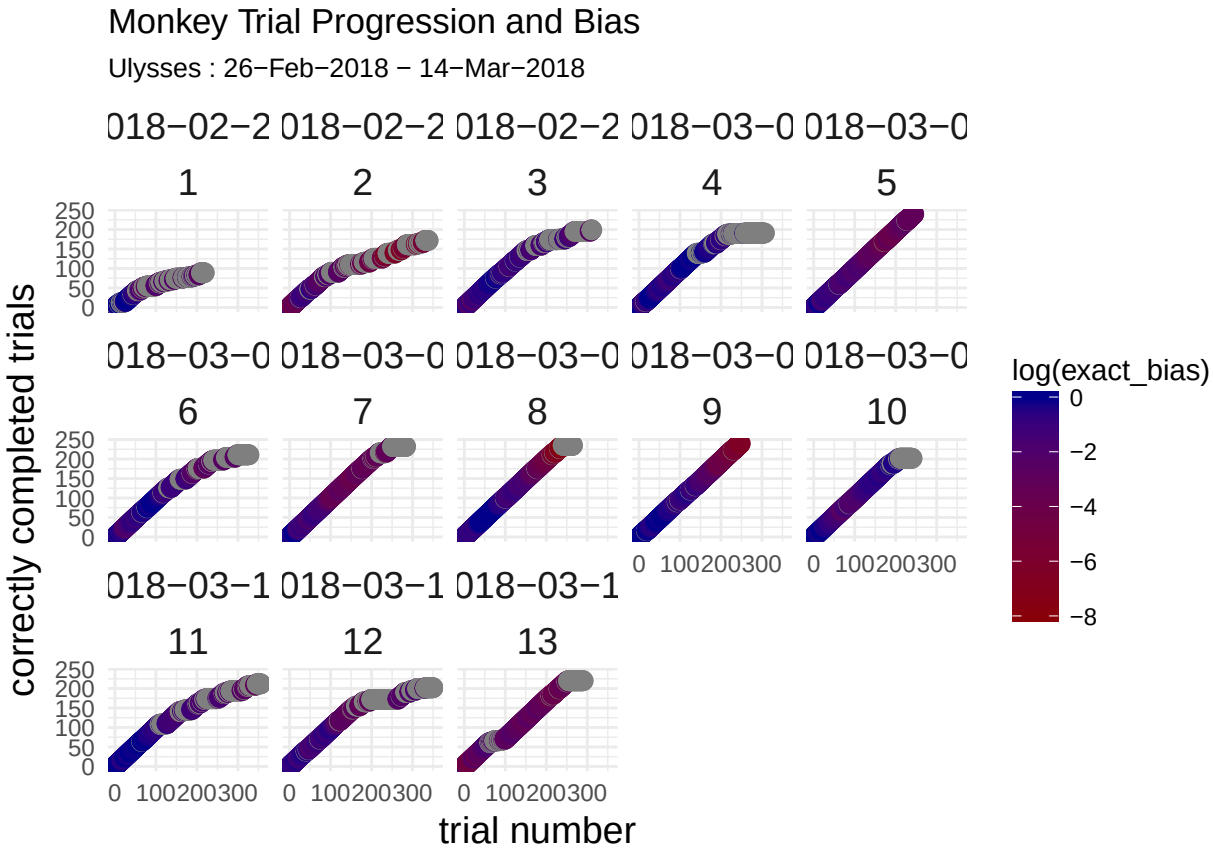
p5


Monkey Bundle Choice Binoimial Curves
Ulysses : 26−Feb−2018 − 14−Mar−2018
0.2
0.32
0.44
proportion of bundle choices
water offered (ml)
block
1
2
3
4
5
6
7
8
9
10
11
12
13

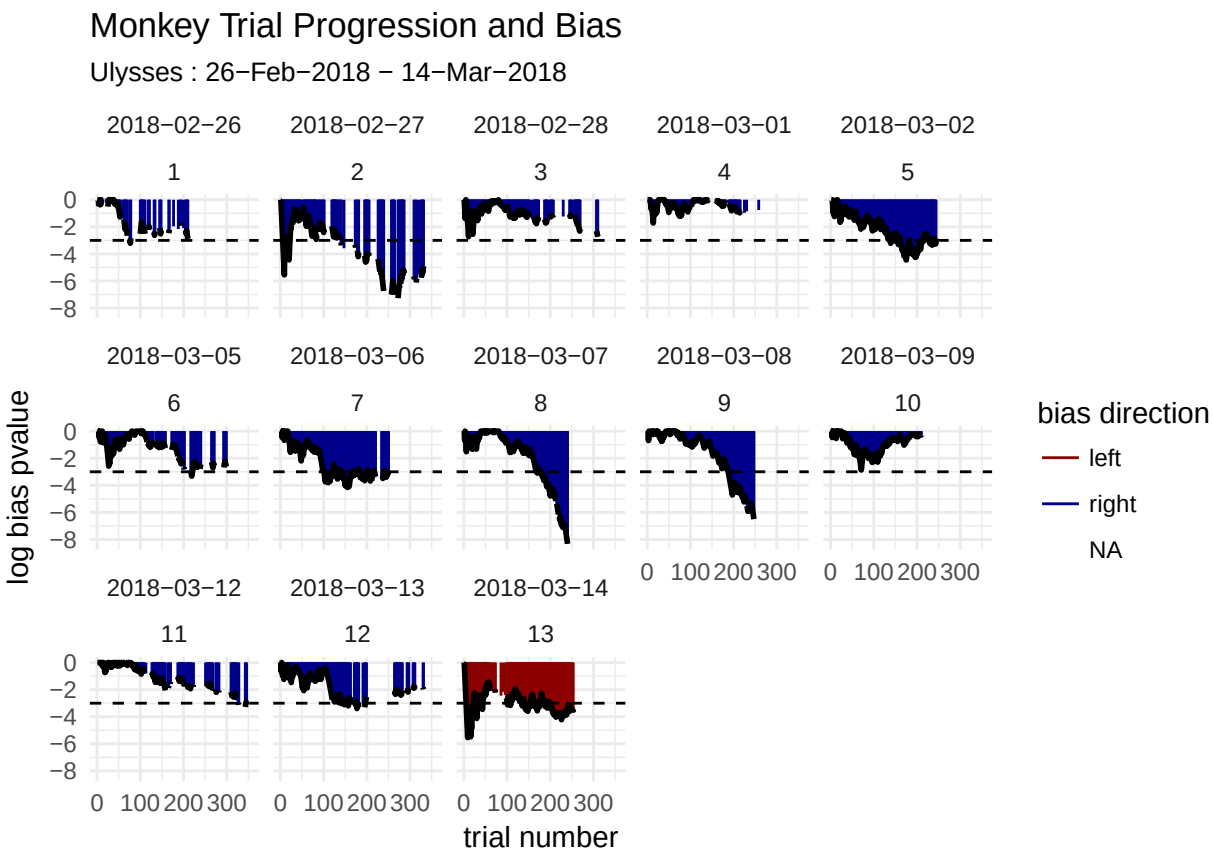
p6


Today's Monkey Bundle Choice Binoimial Curves
Ulysses : 14−Mar−2018
all
proportion of bundle choices
1.00
0.75
0.50
0.25
0.00
0.25
0.50
0.75
1.00
1.25
water offered (ml)
juice offered (ml)
0.2
0.32
0.44

```
p7
```


Monkey Trial Progression and Bias
Ulysses : 26−Feb−2018 − 14−Mar−2018
018−02−2
018−02−2
018−02−2
018−03−0
018−03−0
1
2
3
4
5
018−03−0
018−03−0
018−03−0
018−03−0
018−03−0
6
7
8
9
10
018−03−1
018−03−1
018−03−1
11
12
13
250
200
150
100
50
0
0 100200300
correctly completed trials
trial number
log(exact_bias)
0
−2
−4
−6
−8

```
p8
```


Monkey Trial Progression and Bias
Ulysses : 26−Feb−2018 − 14−Mar−2018
2018−02−26
2018−02−27
2018−02−28
2018−03−01
2018−03−02
2018−03−05
2018−03−06
2018−03−07
2018−03−08
2018−03−09
2018−03−12
2018−03−13
2018−03−14
1
2
3
4
5
6
7
8
9
10
11
12
13
0
−2
−4
−6
−8
0
100
200
300
log bias pvalue
trial number
bias direction
left
right
NA