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Supplementary Materials for

The bystander effect in rats

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This PDF file includes:

Raw data
R code

Supplementary Materials:

Data

The following table shows the opening latencies for 624 sessions of testing. Individual sessions for rats in the trio condition on days 7-12 are listed separately below. For plus group conditions (days 1-6 of trios and all days for duos), the rat # who opened on each day is listed in parentheses; when multiple rats opened together, all rats are listed. In this and the following tables, sessions where a confederate or a trapped rat opened are marked by a C or T, respectively, and were excluded from analysis.

Group abbreviations: C, Control; 1 inc, 1 incompetent helper; 2 inc, 2 incompetent helpers; fam, a Sprague Dawley potential helper familiar with Long-Evans rats and tested with 1 incompetent Long-Evans helper; unfam, a Sprague Dawley potential helper unfamiliar with Long-Evans rats and tested with 1 incompetent Long-Evans helper.

Grp	Cg	D1	D2	D3	D4	D5	D6	D7	D8	D9	D10	D11	D12
trio	1	8 (3)	1 (3)	40	40	2 (2)	40						
trio	2	40	8 (3)	5 (3)	0 (3)	1 (3)	4 (1)						
trio	3	7 (2)	18 (3)	9 (2)	0 (2)	1 (1)	0 (3)						
trio	4	9 (2)	4 (2)	7 (2)	1 (3)	1 (2)	0 (2)						
trio	5	32 (2)	23 (2)	11 (1)	5 (2)	1 (1)	0 (1)						
trio	6	39 (3)	2 (1)	4 (1)	0 (1)	1 (1)	2 (1)						
trio	7	32 (1)	40	6 (2)	7 (2)	12 (2)	1 (3)						

trio	8	40	36 (3)	7 (1)	8 (1)	1 (1,2,3)	6 (1)						
duo	1	40	40	1 (1)	21.2 (2)	0.6 (1)	0.2 (1)	0.2 (1)	1.9 (1)	3.4 (2)	0.6 (2)	0.3 (2)	.7 (2)
duo	2	6.9 (2)	2.3 (2)	2.4 (2)	1.4 (2)	0.1 (2)	0.1 (2)	0.6 (2)	1.4 (2)	0.5 (2)	0.6 (2)	0.2 (1)	0.1 (1)
duo	3	40	40	40	2.3 (1)	1.2 (1)	0 (1)	1.1 (1)	0.2 (1)	19.6 (2)	1 (1)	0.3 (2)	0.5 (1)
duo	4	22.7 (1)	36.9 (1)	9.5 (1)	40	40	40	40	0.8 (1)	0.8 (1)	1.7 (1)	1.1 (1)	0.8 (1)
duo	5	40	40	24.3 (2)	9.3 (2)	1.1 (1)	1.1 (1)	0.8 (1)	0.5 (1)	0.5 (1)	2.5 (2)	3.4 (2)	8.4 (2)
duo	6	12.1 (1)	4.8 (2)	13.6 (1)	1.8 (1)	1.2 (1)	40	37.1 (1)	40	0.7 (1)	0.9 (1)	2.6 (1)	0.8 (1)
duo	7	22.3 (2)	24.4 (2)	8.2 (2)	1.6 (2)	1.4 (1)	0.7 (1)	1.7 (1)	3 (2)	1.2 (2)	1.1 (2)	3.9 (2)	0.5 (2)
duo	8	40	40	10 (1)	13.5 (1)	40	1.6 (1)	13 (2)	0.8 (2)	0.3 (1)	0.2 (1)	0.7 (1)	0.7 (1)
C	1	40	40	40	40	40	40	40	3	6	1	40	2
C	2	40	40	40	40	21	2	0	0	0	1	0	3
C	3	40	40	40	40	25	3	4	2	1	1	1	1
C	4	40	8	4	0	0	0	0	0	0	1	1	1
C	5	40	40	13	17	0	40	40	19	3	40	40	4
C	6	40	40	40	40	40	4	0	0	0	1	0	1
C	7	40	7	40	25	0	13	0	2	0	1	1	1
C	8	40	40	9	3	0	0	0	0	0	1	3	1
1 inc	1	40	40	24.2	8.8	40	40	40	40	33.5	5.4	2	2.1

1 inc	2	40	40	40	40	29.5	2.3	1.7	1.8	0.6	0.4	0.1	0.1
1 inc	3	40	40	40	36.5	10.9	1.4	40	5.3	2.4	0.4	1	0.9
1 inc	4	6.2	C	40	18.9	5	3.4	40	40	40	40	40	40
1 inc	5	C	4.1	40	40	40	2.1	14.1	7.2	3	2.3	2	13.2
1 inc	6	40	40	40	40	40	40	40	40	40	37.4	12.1	40
1 inc	7	40	40	40	20	40	40	40	40	21.5	40	40	40
1 inc	8	40	40	5.2	40	2.7	40	28.5	40	40	5	4	40
2 inc	1	22.8	40	1.4	40	5.5	7.5	40	40	2.9	0.6	1.2	0.8
2 inc	2	40	C	40	40	40	40	40	40	40	40	40	40
2 inc	3	8.3	5	40	1	17.4	0.9	10	14	40	3	2.1	37.8
2 inc	4	40	40	40	T	40	C	5	40	40	3	40	40
2 inc	5	40	40	40	22	40	15.2	40	40	20.9	11.8	0.8	7.5
2 inc	6	C	5	24	39.2	40	C	8	40	40	40	32.1	40
2 inc	7	40	40	40	2	40	40	40	40	40	40	7.3	5.7
2 inc	8	C	10	40	40	39.5	40	40	40	40	40	40	30
fam	1	40	40	40	40	40	6.8	40	40	40	5	13.4	40
fam	2	40	40	40	40	40	40	32.7	C	9.3	40	40	40
fam	3	40	40	40	40	40	40	40	40	40	40	40	40
fam	4	7.6	40	40	40	40	40	40	40	40	40	40	40
fam	5	40	14.6	40	40	40	40	40	40	20	C	25.8	11.8
fam	6	40	40	40	40	40	40	40	40	40	40	40	40
fam	7	40	40	40	40	40	40	40	40	40	40	40	40
fam	8	40	40	40	40	12.5	40	40	40	40	40	40	40
unfam	1	40	40	5.3	2.0	11.2	1.8	1.5	16.4	0.7	3.6	1.2	8
unfam	2	40	40	40	40	40	40	40	40	40	40	40	40
unfam	3	40	40	4.8	2.2	3.4	0.9	1.8	6.3	5.6	1	0.5	1.5
unfam	4	40	40	9.6	4.4	40	0.3	8.3	2.3	4.5	0.4	2.1	0.9

unfam	5	40	10.7	10.4	7.8	1.7	3.4	2.1	0.8	0.9	40	1.9	2.7
unfam	6	40	40	40	12.2	12.1	4.3	4.9	4.3	40	40	40	40
unfam	7	40	40	2.8	40	40	40	40	40	40	40	T	40
unfam	8	40	40	40	40	40	40	C	21.3	6.4	4.4	3.5	7.0

The expanded control group of 48 (demarcated by the lower case *control*) included an additional 40 animals beyond the eight animals marked as C above. These additional animals came from two contemporaneously run experiments (c-A and c-U) with no manipulation and involving two Sprague Dawley male rats. The latencies of the additional 40 animals are listed below.

Grp	D1	D2	D3	D4	D5	D6	D7	D8	D9	D10	D11	D12
c-A	40	40	40	0.9	1.6	1.2	0.1	0.6	0.4	0.6	3.8	2.1
c-A	40	40	40	40	40	40	40	40	40	40	40	40
c-A	40	40	40	40	40	40	40	40	40	40	40	40
c-A	11.8	40	40	40	40	40	40	2	40	40	40	40
c-A	40	25.9	1.1	0.3	0.1	0.3	0.3	0.2	0.1	0.1	0.1	0.1
c-A	40	40	40	40	40	40	8.0	9.0	2.1	0.2	0.8	1.0
c-A	40	21.8	1.2	0.7	0.3	0.2	0.7	0.2	0.1	0.1	0.1	0.1
c-A	40	40.0	40	40	40	40	40	40	24.0	5.2	0.7	1.2
c-A	40	4.4	2.8	0.5	0.7	0.5	0.1	0.2	0.1	0.4	0.2	0.4
c-A	40	40	40	40	40	40	40	40	40	40	40	40
c-A	40	40	6.2	3.4	5.6	1.6	0.6	1.0	0.2	0.1	0.5	0.5
c-A	40	40	40	40	40	40	9.5	4.0	0.3	0.4	0.8	0.6
c-A	40	40	40	3.0	0.3	1.4	0.2	0.8	0.3	1.7	0.2	0.6
c-A	40	40	40	6.3	1.1	6.1	2.8	0.9	1.6	1.0	0.7	1.1
c-A	40	40	40	40	4.0	2.6	0.6	1.1	3.6	0.7	0.5	1.0
c-A	40	6.9	0.4	0.2	0.7	0.5	0.1	0.2	0.2	0.2	0.2	0.2
c-A	40	34.3	3.6	0.9	0.1	0.3	0.6	0.5	0.2	0.2	0.6	0.3
c-A	40	9.9	1.5	0.6	1.3	0.6	0.1	0.2	0.1	0.1	0.1	0.3
c-A	40	40	40	40	40	40	40	40	40	40	40	40
c-A	40	31.0	40	36.9	0.9	0.3	0.6	0.3	0.2	0.2	0.3	0.4
c-A	40	2.8	0.8	0.4	0.2	1.0	0.1	0.1	0.1	0.1	0.4	0.2
c-A	40	40	7.8	0.5	0.6	0.6	0.2	0.7	0.7	0.4	0.4	0.2
c-A	1.9	40	40	40	40	40	40	4.3	9.6	0.6	0.2	0.4
c-A	40	40	40	8.2	40	40	40	40	40	40	6.7	1.0
c-U	40	40	40	40	40	40	40	40	40	40	40	40
c-U	40	40	40	40	6	0	4	1	2	2	0	0
c-U	40	40	40	40	40	40	40	40	40	40	40	40
c-U	40	40	40	40	15	40	40	4	40	2	13	6
c-U	15	12	3	1	1	0	1	1	1	1	0	1
c-U	40	40	40	40	40	7	5	2	1	0	2	3

c-U	40	40	15	5	5	0	0	0	0	0	0	1
c-U	40	40	40	40	40	40	40	40	40	40	40	40
c-U	40	40	7	25	33	2	2	0	0	0	0	0
c-U	16	40	40	36	17	0	1	35	2	1	0	0
c-U	40	40	40	40	4	13	3	3	40	5	33	1
c-U	40	40	8	1	8	4	0	1	0	2	3	2
c-U	40	40	40	40	40	40	40	40	40	40	40	40
c-U	40	40	40	40	40	40	40	40	40	40	40	40
c-U	21	4	2	16	4	1	3	0	0	0	1	0
c-U	40	40	40	40	40	40	40	40	40	40	40	40

The opening latencies for individual free rats in the trio condition are listed below. Note that on days 1-6, rats were tested as a group of three. On days 7-12, rats were tested individually. Note that on these days, rats were tested for 30 minutes and therefore 30 indicates no-opening.

Cg	Rat	D7	D8	D9	D10	D11	D12
1	1	0	30	0	10	30	30
2	1	3	30	2	8	0	30
3	1	14	1	1	30	0	2
4	1	30	1	13	15	30	30
5	1	30	30	30	10	30	30
6	1	30	3	6	5	2	1
7	1	30	30	30	30	8	30
8	1	2	2	0	12	17	30
1	2	30	30	30	0	30	30
2	2	7	1	1	0	6	30
3	2	1	1	30	30	2	1
4	2	30	1	30	30	30	30
5	2	0	1	2	0	4	30
6	2	0	1	2	0	0	1
7	2	4	2	3	0	1	5
8	2	20	3	18	1	5	6

1	3	30	30	30	0	30	30
2	3	0	30	2	0	0	1
3	3	4	8	0	30	30	30
4	3	3	0	10	30	30	30
5	3	3	0	30	30	30	30
6	3	0	0	0	30	30	30
7	3	30	30	30	30	11	30
8	3	13	0	3	3	4	5

R code

The following code was used in R version 3.5.1 to calculate shuffled groups of two and three rats. Output is a data frame (not shown), with opening latencies calculated for each trial, as described in methods.

```

rat_data <- read.csv('StandardRatsToModelN48.csv')
rat_data$Rat_ID <- 1:length(rat_data$D1)
rat_data <- subset(rat_data, select = D1:Rat_ID)

N_days <- 12
Output_all <- list()

for (N_rats in 2:3) {
  N_trials <- factorial(48) / (factorial(N_rats) * factorial(48 - N_rats))
  all_combinations <- (combn(1:48, N_rats, simplify=FALSE))

  Output <- list()

  for (i in 1:N_trials) {
    rows <- unlist(all_combinations[i])
    rats <- rat_data[c(rows),]
    Rat_Stats <- data.frame(matrix(ncol = 4, nrow = N_days))
    colnames(Rat_Stats) <- c('Winner1', 'Winner2', 'Winner3', 'OpeningTime')
    for (j in 1:N_days){
      Opening <- !all(rats[, j] == 40)
      if (Opening == FALSE) {
        Rat_Stats[j, "OpeningTime"] <- 40
        Winner <- NA
        Middle <- NA
        Loser <- NA
      } else if (Opening == TRUE) {
        ordered_rats <- rats[order(rats[, j]),]
        num_unique <- length(unique(rats[, j]))
        Rat_Stats[j, "OpeningTime"] <- ordered_rats[1, j]

        if (num_unique == N_rats) {
          Winner <- ordered_rats[1, "Rat_ID"]
          Loser <- ordered_rats[2, "Rat_ID"]
          if (N_rats == 3) {
            Middle <- ordered_rats[2, "Rat_ID"]
            Loser <- ordered_rats[3, "Rat_ID"]
          }
        } else if (num_unique == (N_rats - 1)) {
          winner_row <- sample(1:2, 2)
          Winner <- ordered_rats[(winner_row[1]), "Rat_ID"]
          Loser <- ordered_rats[(winner_row[2]), "Rat_ID"]
          if (N_rats == 3) {
            Middle <- ordered_rats[(winner_row[2]), "Rat_ID"]
            Loser <- ordered_rats[3, "Rat_ID"]
          }
        }
      }
    }
  }
}

```



```

    } else if (num_unique == (N_rats - 2)) {
      winner_row <- sample(1:3, 3)
      Winner <- ordered_rats[(winner_row[1]), "Rat_ID"]
      Middle <- ordered_rats[(winner_row[2]), "Rat_ID"]
      Loser <- ordered_rats[(winner_row[3]), "Rat_ID"]
    }
  }
  Rat_Stats[j, "Winner1"] <- Winner
  Rat_Stats[j, "Winner2"] <- Loser
  if (N_rats == 3) {
    Rat_Stats[j, "Winner2"] <- Middle
    Rat_Stats[j, "Winner3"] <- Loser
  }

  N_openings <- sum(!is.na(Rat_Stats$Winner1))
  Rat1 <- rows[1]
  Rat2 <- rows[2]
  Rat1_Wins <- sum(Rat_Stats$Winner1 == Rat1, na.rm = TRUE) / N_openings
  Rat2_Wins <- sum(Rat_Stats$Winner1 == Rat2, na.rm = TRUE) / N_openings
  Rat3_Wins <- NA
  if (N_rats == 3) {
    Rat3 <- rows[3]
    Rat3_Wins <- sum(Rat_Stats$Winner1 == Rat3, na.rm = TRUE) /
N_openings
  }
  Trial_output <- list('Trial' = i,
                     'Rat_combination' = paste(rows, collapse = ", "),
                     'D1_Lat' = Rat_Stats$OpeningTime[1],
                     'D2_Lat' = Rat_Stats$OpeningTime[2],
                     'D3_Lat' = Rat_Stats$OpeningTime[3],
                     'D4_Lat' = Rat_Stats$OpeningTime[4],
                     'D5_Lat' = Rat_Stats$OpeningTime[5],
                     'D6_Lat' = Rat_Stats$OpeningTime[6],
                     'D7_Lat' = Rat_Stats$OpeningTime[7],
                     'D8_Lat' = Rat_Stats$OpeningTime[8],
                     'D9_Lat' = Rat_Stats$OpeningTime[9],
                     'D10_Lat' = Rat_Stats$OpeningTime[10],
                     'D11_Lat' = Rat_Stats$OpeningTime[11],
                     'D12_Lat' = Rat_Stats$OpeningTime[12],
                     'Rat1_Openings' = Rat1_Wins,
                     'Rat2_Openings' = Rat2_Wins,
                     'Rat3_Openings' = Rat3_Wins
                    )
}
Output <- append(Output, list(Trial_output))
}
Output_all <- append(Output_all, list(Output))
}

```

```
names(Output_all) <- c("2 Rats", "3 Rats")
```

```
DuosShuffle <- do.call(rbind.data.frame, Output_all$`2 Rats`)
```

```
TriosShuffle <- do.call(rbind.data.frame, Output_all$`3 Rats`)
```