

Domenech_Analysis_Both

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This is a new script for Sept 2021 to treat both Dali and Pippa data at the same time, and to consider 3 periods of work.

Detailed schedule for the two monkeys can be found in Training history.docx, but here we consider 3 periods of the Switch Task: ST1 – from the start of Switch Task just after transfer - criterion learning... ST2 – from when they learn without criterion to surgery ST3 – later period with stable recordings and well after surgery (P& D only)

Previous scripts cover only ST3 (for example teh first Domenech_Analysis)

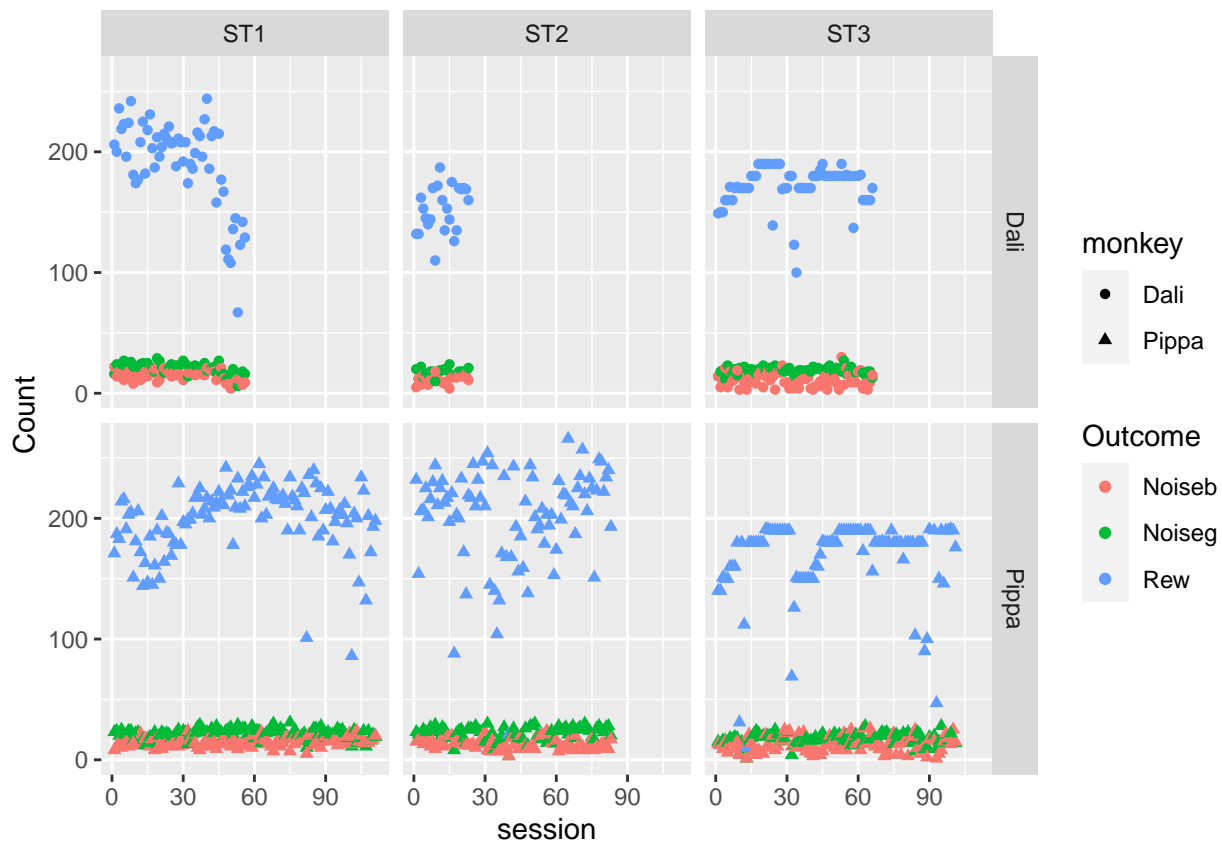
Data are loaded from pre-prepared data files, see the silenced chunks for loading of new data or parameters.

First load the major datafile

```
# Where are the data?
paths <- ("/Users/charliewilson/Dropbox/Brain Lyon/Reversible Cognition/Domenech_Analysis/Behaviour/");

load(file = paste(paths, "/All_Data_ST123.Rdata", sep = ""))
```

What is in each session?



Let's build a trial by trial matrix to help the trial analysis, and populate it with the necessary information on each trial and TS

```
# First some summary statistics from the whole trial
Dat <- Dat %>%
  dplyr::group_by(monkey,Phase,session,trial) %>%
  dplyr::mutate(GNorm = sum(event == 150), BNorm = sum(event == 151),GTrap = sum(event == 152), BTrap =
  dplyr::ungroup()

# And use that to extract if the response was correct or not
Dat <- Dat %>%
  dplyr::group_by(monkey,Phase,session,trial) %>%
  dplyr::mutate(COR = max(GNorm | GTrap), INC = max(BNorm | BTrap)) %>%
  dplyr::ungroup()

# Extract response
Dat <- Dat %>%
  dplyr::group_by(monkey,Phase,session,trial) %>%
  dplyr::mutate(Resp =
    case_when(
      sum(event == 61)>0 ~ 1,
      sum(event == 62)>0 ~ 2,
      sum(event == 63)>0 ~ 3)) %>%
  dplyr::ungroup()

# Now extract the first line of each trial
#rm ('Trials')
```

```

Trials <- Dat %>%
  dplyr::group_by(monkey,Phase,session,trial) %>%
  slice(1)
Trials <- subset(Trials, COR>0 | INC>0) # Just trials with an outcome

# Extract the previous trial info for Stim and Rew
Trials <- Trials %>%
  dplyr::group_by(monkey,Phase,session) %>%
  dplyr::mutate(PrevSt=lag(Stim), PrevOut=lag(COR) ) %>%
  dplyr::ungroup()

# How many rewards in the last 3 trials?
Trials <- Trials %>%
  dplyr::group_by(monkey,Phase,session) %>%
  dplyr::mutate(roll_sum = roll_sum(Rew, 4, align = "right", fill = NA)) %>%
  dplyr::ungroup()

# We want a new DF with the outcomes around each trap
TrapI <- which(Trials$GTrap == 1 | Trials$BTrap == 1)

# Count trials since and to the Gtraps
# First track cycles of GTraps
Trials <- Trials %>%
  dplyr:: group_by(monkey,Phase,session) %>%
  dplyr:: mutate(GTrapCyc = cumsum(GTrap)) %>%
  dplyr:: ungroup()

# Then count forward and backward
Trials <- Trials %>%
  dplyr::group_by(monkey,Phase,session,GTrapCyc) %>%
  dplyr::mutate(GTrapC = row_number()-1,GTrapCback = row_number() - (n()+1))

# Subset down to trials just around Traps and set t around Traps
#rm ('Traps', 'TrapSE')
Traps <- subset(Trials, GTrapC <=2 | GTrapCback == -1)
# The trial BEFORE each trap belongs to the GTrapCyc of the trap that comes just after for this analysis.
Traps$GTrapCyc <- lead(Traps$GTrapCyc) #Shift up 1
Traps$t <-Traps$GTrapC
Traps$t[Traps$t>2] <- -1

# Is the response the same as the Trap?
Traps <- Traps %>%
  group_by(monkey,Phase,session,GTrapCyc) %>%
  dplyr::mutate(TrapR = nth(Resp,2), SameRT = as.integer(TrapR==Resp))

# Is the stimulus the same as the Trap?
Traps <- Traps %>%
  group_by(monkey,Phase,session,GTrapCyc) %>%
  dplyr::mutate(TrapS = nth(Stim,2), SameST = as.integer(TrapS==Stim))

TrapSSame <- subset(Traps, SameST == 1)
TrapSDif <- subset(Traps, SameST == 0)

```

Use this to produce a monkey version of the figures from PD's AI manuscript

```

#Test <- table(TrapSSame$SameRT)

# summarySE provides the standard deviation, standard error of the mean, and a (default 95%) confidence
# We need the summary for the different t values -1 to 2
# But for t=2 only we need to split on the basis of PrevOut
# The following is an ugly way of achieving this...
SS1 <- summarySE(TrapSSame, measurevar="SameRT", groupvars=c("t", "PrevOut", "monkey", "Phase"))

##
## Attaching package: 'doBy'

## The following object is masked from 'package:dplyr':
##
##      order_by

SS1 <- subset(SS1, t==2 & !is.na(PrevOut), select=-PrevOut)
SS2 <- summarySE(TrapSSame, measurevar="SameRT", groupvars=c("t", "monkey", "Phase"))
SS2 <- subset(SS2, t<2 & t!=0)
SumSame <- rbind(SS2, SS1)

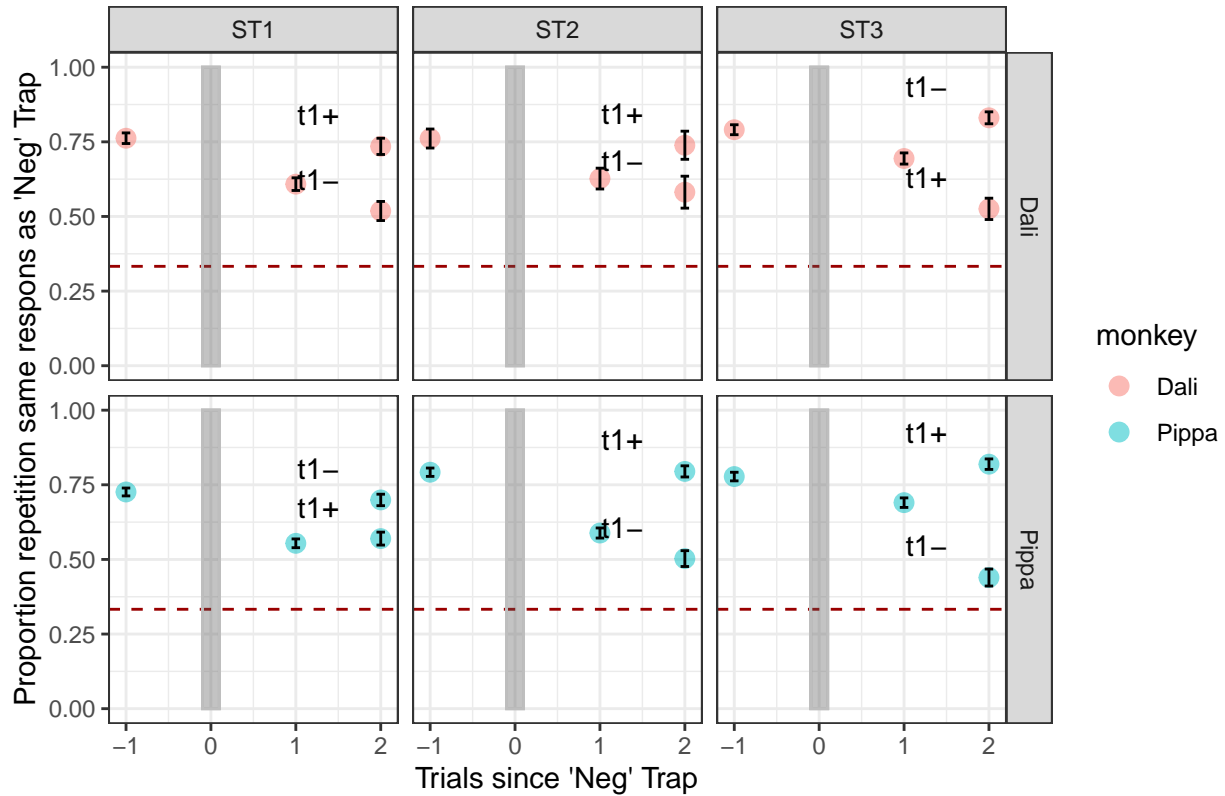
# Also for the Different stimulus...
SD1 <- summarySE(TrapSDif, measurevar="SameRT", groupvars=c("t", "PrevOut", "monkey", "Phase"))
SD1 <- subset(SD1, t==2 & !is.na(PrevOut), select=-PrevOut)
SD2 <- summarySE(TrapSDif, measurevar="SameRT", groupvars=c("t", "monkey", "Phase"))
SD2 <- subset(SD2, t<2)
SumDif <- rbind(SD2, SD1)

# Reproduce figs 2a,b from the Domenech Manuscript
xxx <- c("t1-", "t1-", "t1+", "t1+")

ggplot(SumSame, aes(x=t, y=SameRT)) + #What data to plot
  geom_point(aes(colour=monkey), size=3, alpha = 0.5) +
  geom_text(aes(label=ifelse(t>1, xxx, '')), hjust=2, vjust=-1) +
  geom_errorbar(aes(ymin=SameRT-se, ymax=SameRT+se), width=.1) +
  ylim(0, 1) +
  geom_hline(aes(yintercept=0.333), colour="#990000", linetype="dashed") +
  geom_rect(aes(xmin=-0.1, xmax=0.1, ymin=0, ymax=1), color="grey", alpha=0.1) +
  ggtitle("Same Stimulus as 'Negative' Trap on t0") +
  theme(plot.title = element_text(hjust = 0.5)) +
  ylab("Proportion repetition same respons as 'Neg' Trap") +
  xlab("Trials since 'Neg' Trap") +
  facet_grid(monkey ~ Phase) +
  theme_bw()

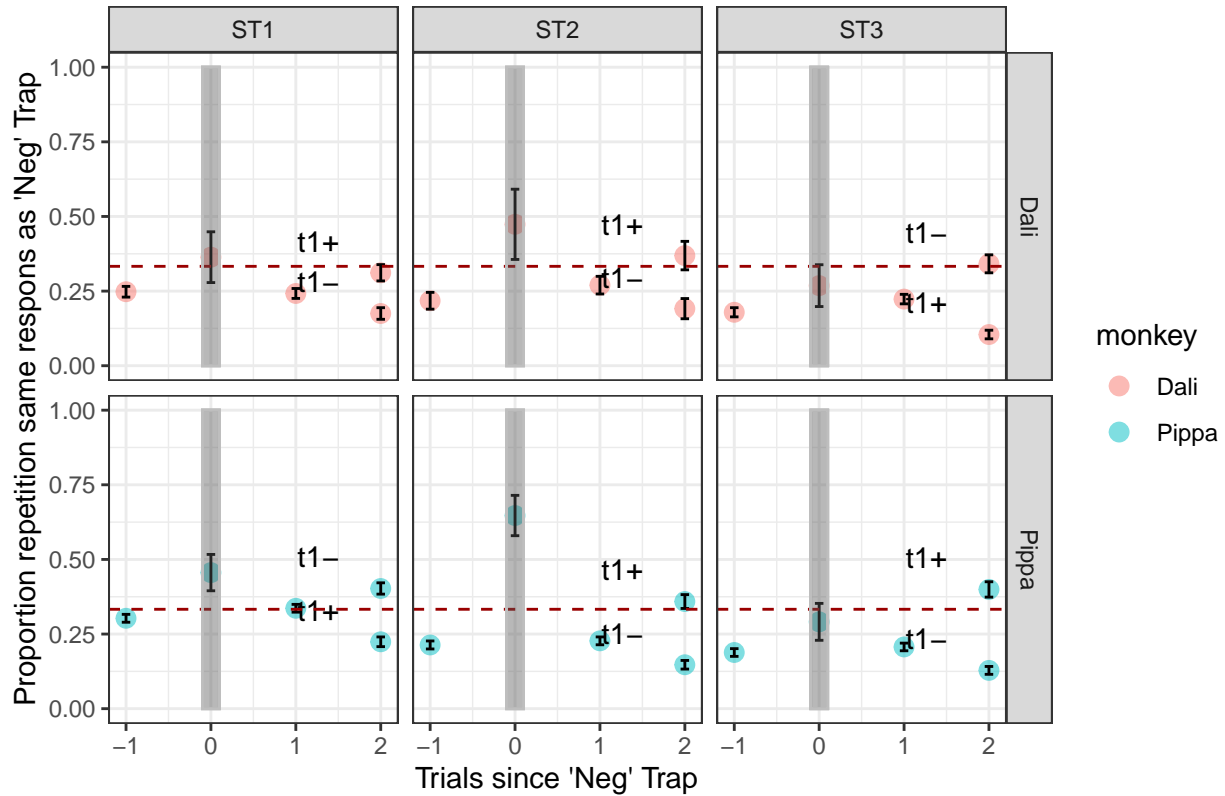
```

Same Stimulus as 'Negative' Trap on t0



```
ggplot(SumDif, aes(x=t,y=SameRT)) + #What data to plot
  geom_point(aes(colour=monkey), size=3,alpha = 0.5)+
  geom_text(aes(label=ifelse(t>1,xxx,'')),hjust=2,vjust=-1) +
  geom_errorbar(aes(ymin=SameRT-se, ymax=SameRT+se), width=.1) +
  ylim(0,1) +
  geom_hline(aes(yintercept=0.333), colour="#990000", linetype="dashed") +
  geom_rect(aes(xmin=-0.1, xmax=0.1, ymin=0, ymax=1), color="grey", alpha=0.1) +
  ggtitle("Different Stimulus from 'Negative' Trap on t0") +
  theme(plot.title = element_text(hjust = 0.5)) +
  ylab("Proportion repetition same respons as 'Neg' Trap") +
  xlab("Trials since 'Neg' Trap") +
  facet_grid(monkey ~ Phase)+
  theme_bw()
```

Different Stimulus from 'Negative' Trap on t0



Reproduce figs 2c,d from the Domenech Manuscript

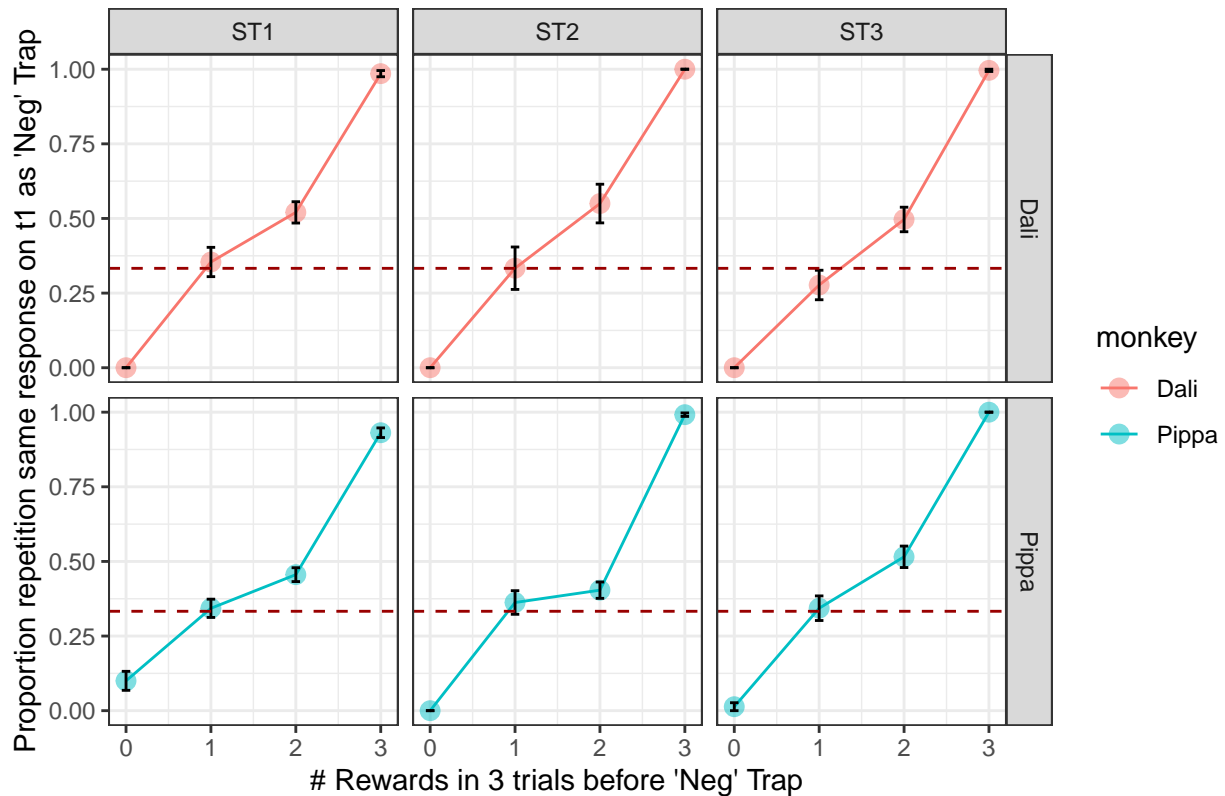
Summarise rolling sum of same resp

```
Sumt1same <- summarySE(subset(TrapSSame,t==1), measurevar="SameRT", groupvars=c("roll_sum","monkey","Phase"))
```

```
Sumt1dif <- summarySE(subset(TrapSDif,t==1), measurevar="SameRT", groupvars=c("roll_sum","monkey","Phase"))
```

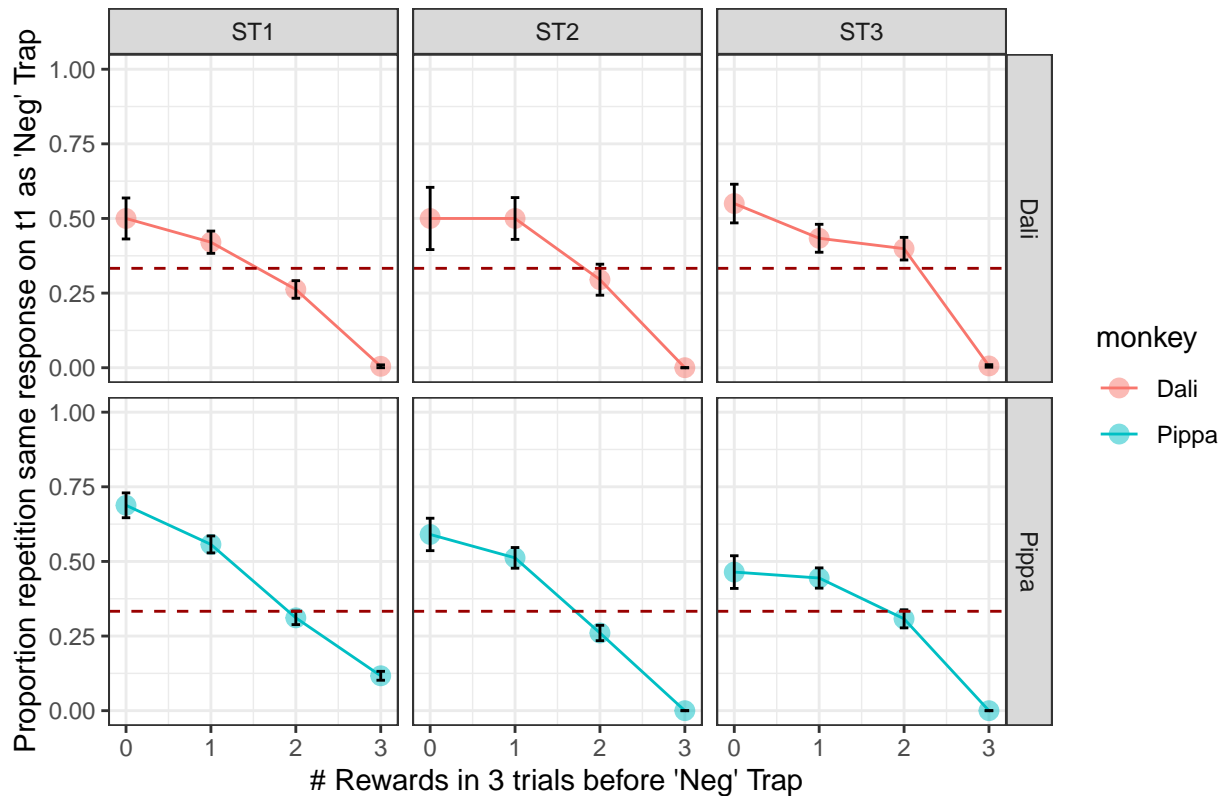
```
ggplot(Sumt1same, aes(x=roll_sum,y=SameRT)) + #What data to plot
  geom_point(aes(colour=monkey), size=3,alpha = 0.5)+
  geom_line(aes(colour=monkey))+
  geom_errorbar(aes(ymin=SameRT-se, ymax=SameRT+se), width=.1) +
  ylim(0,1) +
  geom_hline(aes(yintercept=0.333), colour="#990000", linetype="dashed") +
  ggtitle("Same Stimulus as 'Negative' Trap on t0") +
  theme(plot.title = element_text(hjust = 0.5)) +
  ylab("Proportion repetition same response on t1 as 'Neg' Trap") +
  xlab("# Rewards in 3 trials before 'Neg' Trap") +
  facet_grid(monkey ~ Phase)+
  theme_bw()
```

Same Stimulus as 'Negative' Trap on t0



```
ggplot(Sumtidif, aes(x=roll_sum,y=SameRT)) + #What data to plot
  geom_point(aes(colour=monkey), size=3,alpha = 0.5)+
  geom_line(aes(colour=monkey)) +
  geom_errorbar(aes(ymin=SameRT-se, ymax=SameRT+se), width=.1) +
  ylim(0,1) +
  geom_hline(aes(yintercept=0.333), colour="#990000", linetype="dashed") +
  ggtitle("Different Stimulus from 'Negative' Trap on t0") +
  theme(plot.title = element_text(hjust = 0.5)) +
  ylab("Proportion repetition same response on t1 as 'Neg' Trap") +
  xlab("# Rewards in 3 trials before 'Neg' Trap") +
  facet_grid(monkey ~ Phase)+
  theme_bw()
```

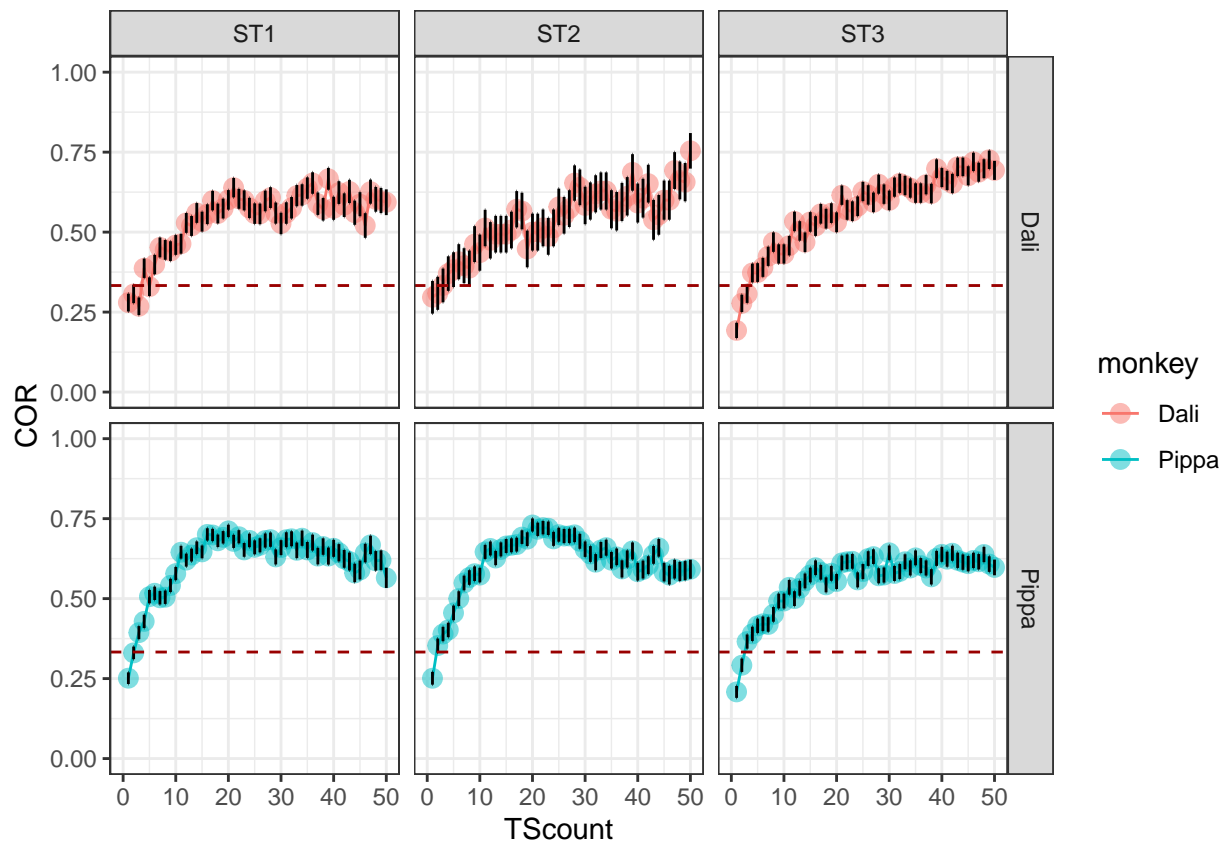
Different Stimulus from 'Negative' Trap on t0



Performance of the 2 monkeys across the 3 stages of this task is fairly similar and strong. The monkeys look very much like the “good learner” humans in the PD manuscript, without the AI lesion. There is possibly a reduction in the trap reactivity across phases, so will study this below.

So how does the monkeys' within-TS learning change across the stages?

```
# Counter in each TS
Trials <- Trials %>%
  group_by(monkey, Phase, session, TS) %>%
  dplyr::mutate(TScount = row_number(), TSperc = mean(COR))
# Summarise % correct
TSsum <- summarySE(Trials, measurevar="COR", groupvars=c("TScount", "monkey", "Phase"))
# Plot % correct through TS
ggplot(TSsum, aes(x=TScount, y=COR)) +
  geom_point(aes(colour=monkey), size=3, alpha = 0.5) +
  geom_line(aes(colour=monkey)) +
  geom_errorbar(aes(ymin=COR-se, ymax=COR+se), width=.1) +
  geom_hline(aes(yintercept=0.333), colour="#990000", linetype="dashed") +
  xlim(0, 50) +
  facet_grid(monkey ~ Phase) +
  theme_bw()
```

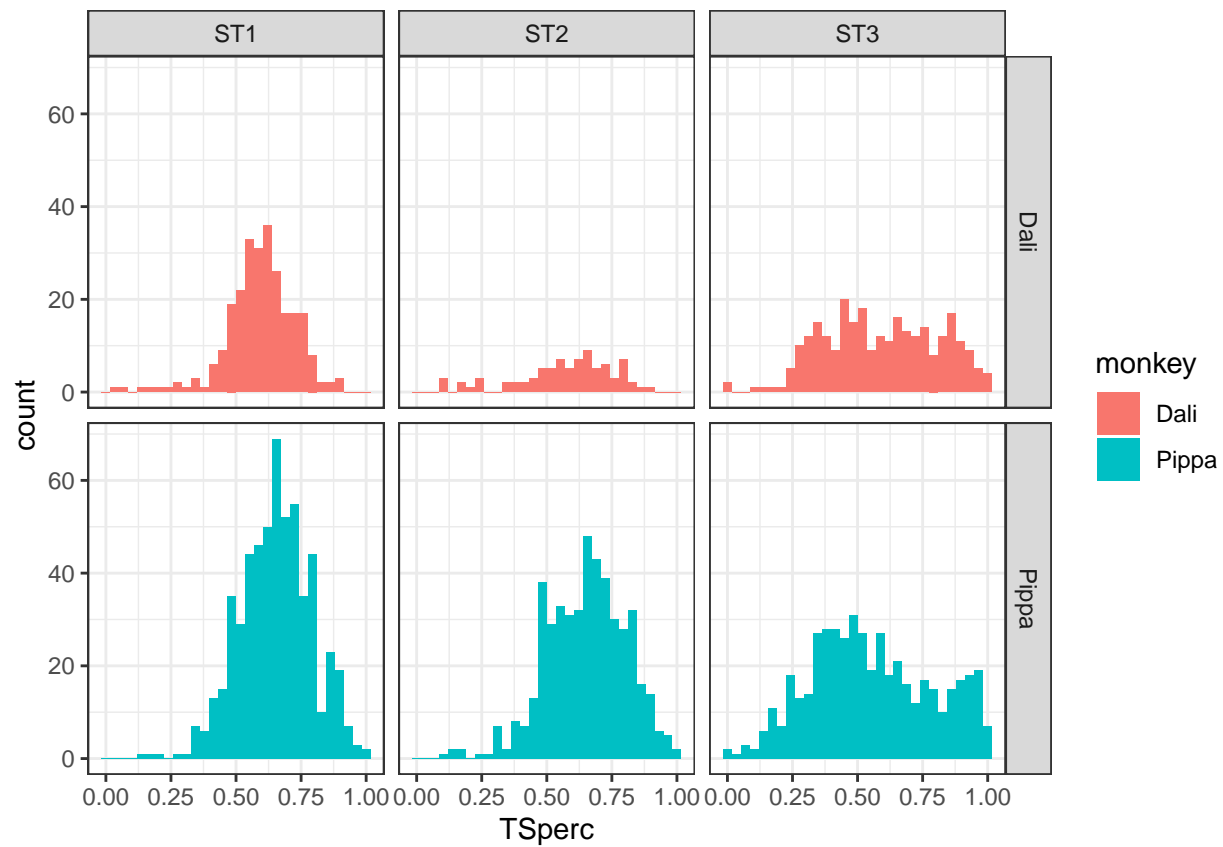



#How well are the TSs solved? Is there a pattern over time?

```
TSs <- Trials %>%
  dplyr::group_by(monkey, Phase, session, TS) %>%
  slice(1)
```

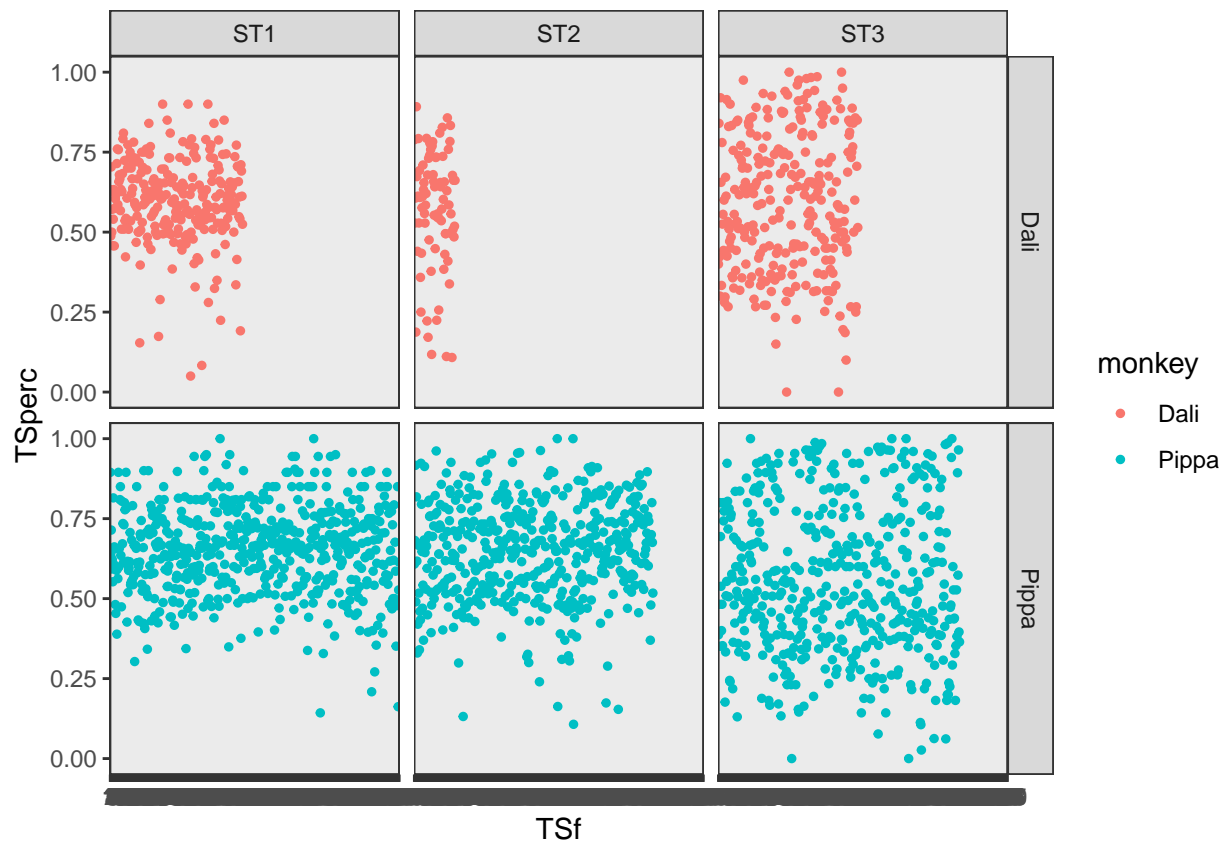
```
ggplot(TSs, aes(x=TSperc, fill = monkey)) +
  geom_histogram(position="dodge")+
  facet_grid(monkey ~ Phase)+
  theme_bw()
```

```
## `stat_bin()` using `bins = 30`. Pick better value with `binwidth`.
```

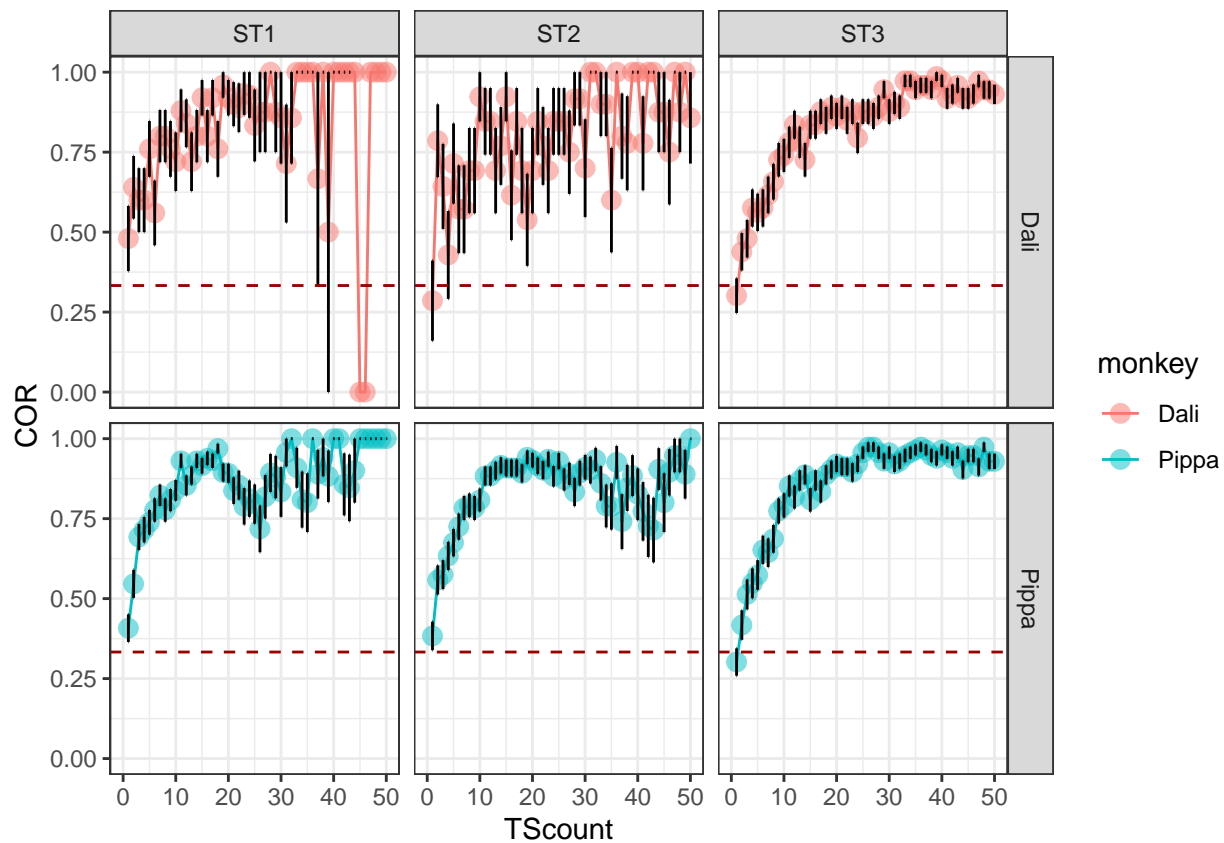


```
#Over time
TSs <- TSs %>%
  dplyr::group_by(monkey,Phase) %>%
  dplyr::mutate(TSf = as.factor(row_number()))

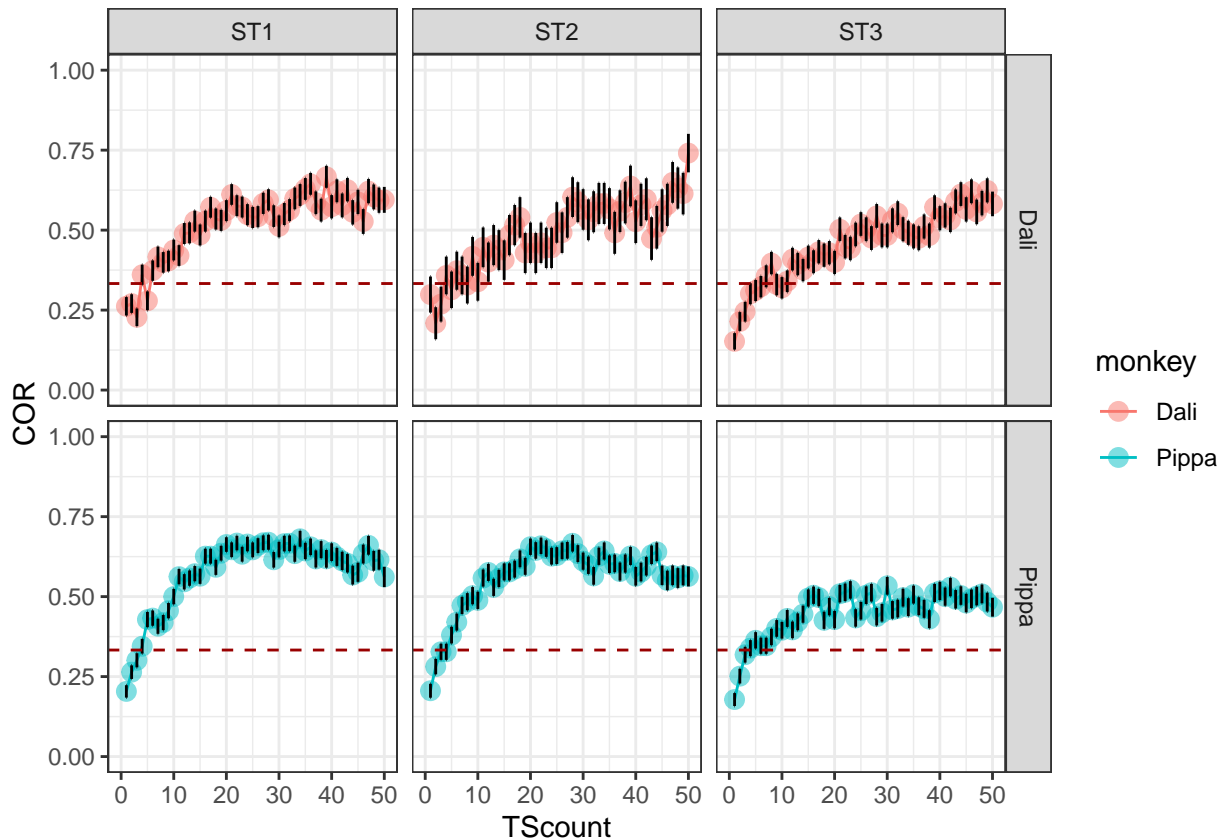
ggplot(TSs, aes(x=TSf, y=TSperc)) +
  geom_point(aes(colour=monkey), size=1)+
  facet_grid(monkey ~ Phase)+
  theme_bw()
```



```
#Look at only the good TSs
GoodTS <- subset(Trials, TSperc>0.75)
GoodTSsum <- summarySE(GoodTS, measurevar="COR", groupvars=c("TScount","monkey","Phase"))
ggplot(GoodTSsum, aes(x=TScount, y=COR)) +
  geom_point(aes(colour=monkey), size=3,alpha = 0.5)+
  geom_line(aes(colour=monkey)) +
  geom_errorbar(aes(ymin=COR-se, ymax=COR+se), width=.1) +
  geom_hline(aes(yintercept=0.333), colour="#990000", linetype="dashed") +
  xlim(0,50) +
  facet_grid(monkey ~ Phase)+
  theme_bw()
```



```
#Look at only the bad TSs
BadTS <- subset(Trials, TSperc<0.75)
BadTSsum <- summarySE(BadTS, measurevar="COR", groupvars=c("TScout","monkey","Phase"))
ggplot(BadTSsum, aes(x=TScout, y=COR)) +
  geom_point(aes(colour=monkey), size=3,alpha = 0.5)+
  geom_line(aes(colour=monkey)) +
  geom_errorbar(aes(ymin=COR-se, ymax=COR+se), width=.1) +
  geom_hline(aes(yintercept=0.333), colour="#990000", linetype="dashed") +
  xlim(0,50) +
  facet_grid(monkey ~ Phase)+
  theme_bw()
```



The comparison here is tricky as there is a criterion in ST1 but not afterwards. Maybe learning is initially faster in later STs? But overall there is a wider spread and more bad TSs in the later STs

Now we want to reproduce some of the figures from Faraut et al 2016, but for the current dataset

#Let's look at trap reactivity as %COR (Fig 4A Faraut)

#Need to consider both Trap types, so need a Trap count that does that

Count trials since and to the Gtraps

```
Trials <- Trials %>%
  group_by(monkey, Phase) %>%
  mutate (Traps = cumsum(GTrap+BTrap))
#max(Trials$Traps)
#sum(Trials$GTrap + Trials$BTrap)

Trials <- Trials %>%
  group_by(monkey, Phase, Traps) %>%
  dplyr::mutate(TrapC = row_number()-1, TrapCback = row_number() - (n()+1))
```

Subset down to trials just around Traps and set t around Traps

#rm ('Traps', 'TrapSE')

```
AllTraps <- subset(Trials, TrapC <=4 | TrapCback >= -4)
```

```
AllTraps <- transform(AllTraps, tt = ifelse(TrapC>4, TrapCback, TrapC))
```

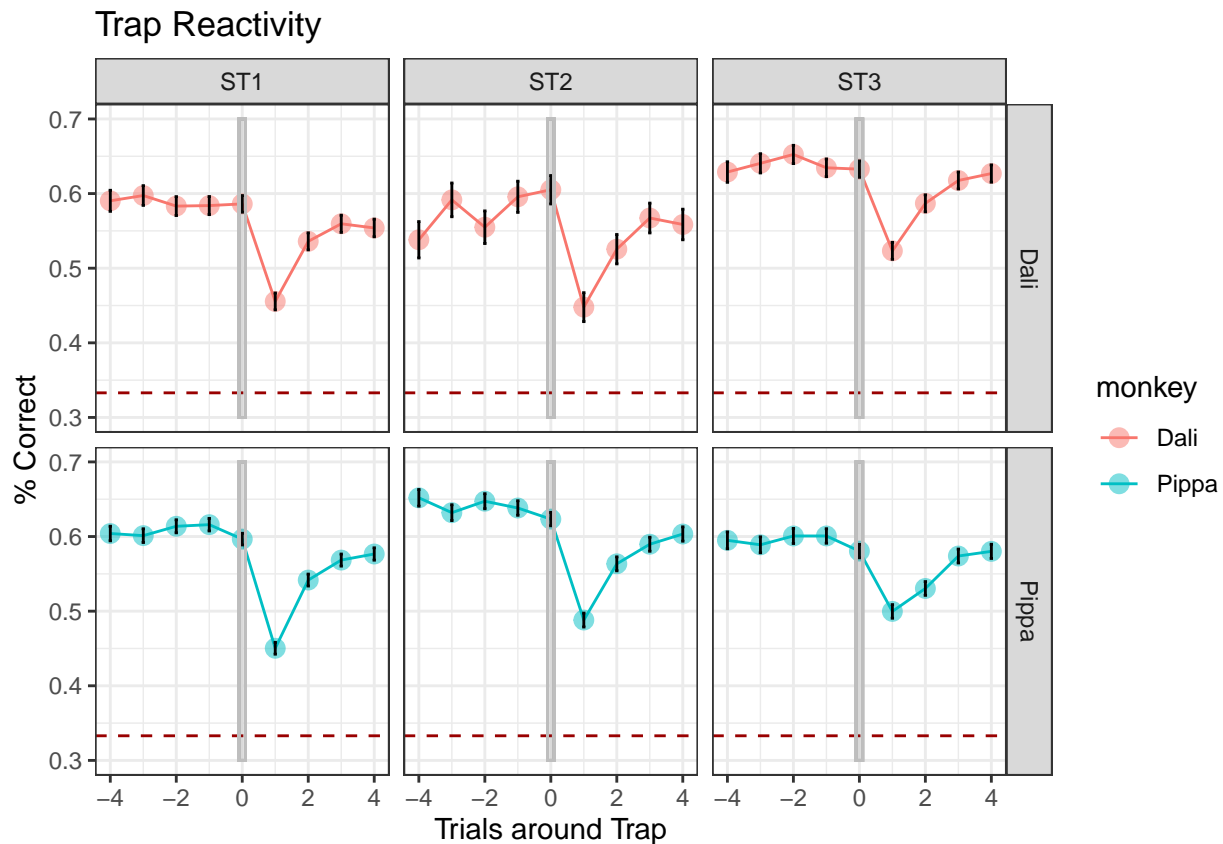
```
TrapReac <- summarySE(AllTraps, measurevar="COR", groupvars=c("tt", "monkey", "Phase"))
```

```
ggplot(TrapReac, aes(x=tt, y=COR)) + #What data to plot
```

```

geom_point(aes(color=monkey),size=3,alpha=0.5)+
geom_line(aes(color=monkey)) +
geom_errorbar(aes(ymin=COR-se, ymax=COR+se), width=.1) +
ylim(0.3,0.7) +
geom_hline(aes(yintercept=0.333), colour="#990000", linetype="dashed") +
geom_rect(aes(xmin=-0.1, xmax=0.1, ymin=0.3, ymax=0.7), color="grey", alpha=0.01) +
ggtitle("Trap Reactivity") +
theme(plot.title = element_text(hjust = 0.5)) +
ylab("% Correct") +
xlab("Trials around Trap")+
facet_grid(monkey ~ Phase)+
theme_bw()

```



So in the early version the Trap reactivity is greater than it is more recently, but there are pre-trap differences between the monkeys so interpretation is hard. To be discussed...