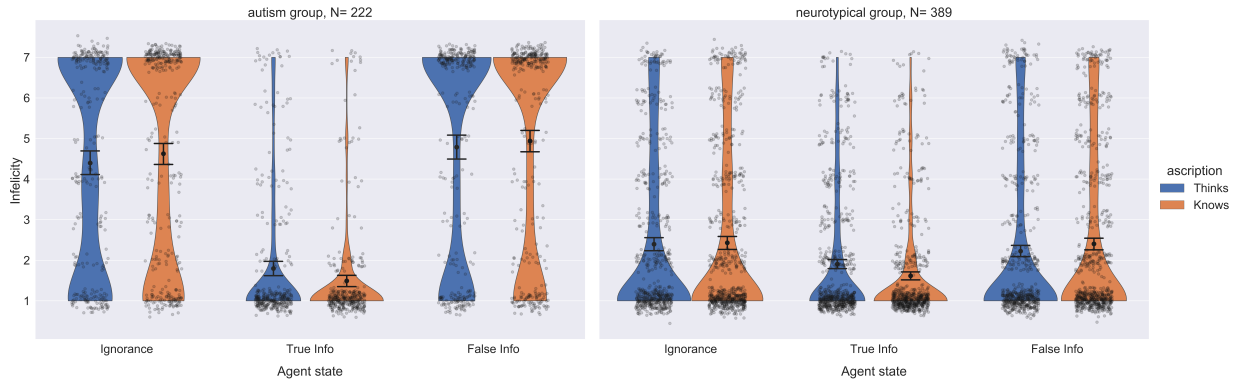
Infelicity Judgements Analysis

```
## Loading required package: Matrix
```

Between Groups Analysis

3-way Interaction of Group x Agent State x Ascription




```
#mb0 = lmer('infelicity ~ group*agent_state*ascription + (agent_state + ascription|item) + (agent_state
mb1 = lmer('infelicity ~ group:agent_state + group:ascription + agent_state:ascription + (agent_state +
```

```
## fixed-effect model matrix is rank deficient so dropping 1 column / coefficient
```

```
## boundary (singular) fit: see help('isSingular')
```

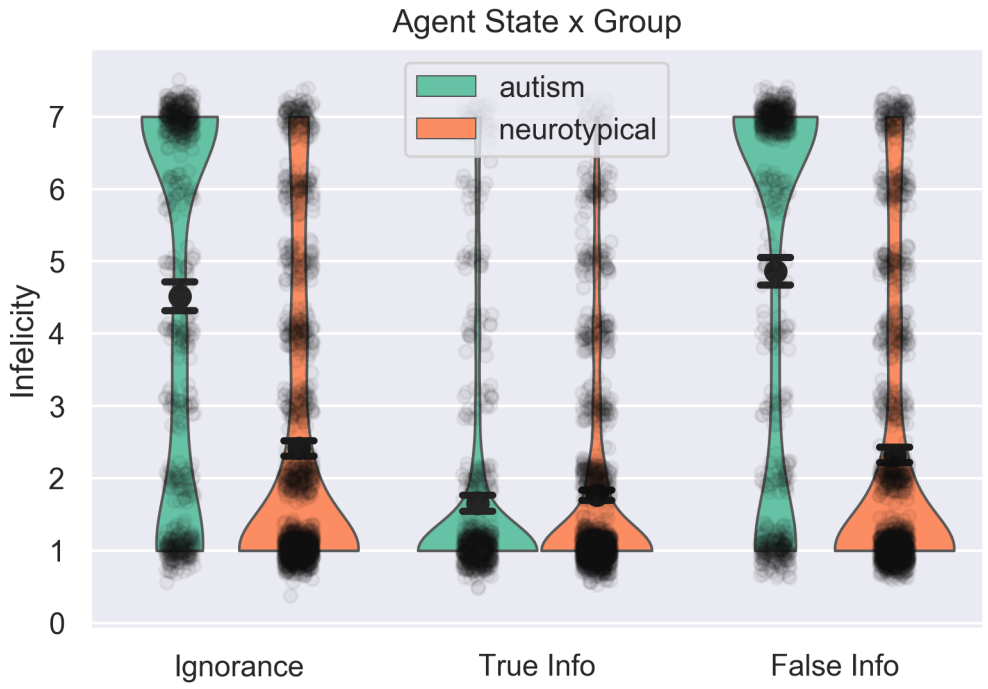
```
#grpxagntxascrpt <- anova(mb0, mb1)
#saveRDS(grpxagntxascrpt, 'grpxagntxascrpt_fel.rda')
grpxagntxascrpt <- readRDS('grpxagntxascrpt_fel.rda')
grpxagntxascrpt
```

```
## Data: df
## Models:
## mb1: "infelicity ~ group:agent_state + group:ascription + agent_state:ascription + (agent_state + as
## mb0: "infelicity ~ group*agent_state*ascription + (agent_state + ascription|item) + (agent_state|sub
##     npar   AIC   BIC logLik deviance Chisq Df Pr(>Chisq)
## mb1   27 23845 24027 -11896    23791
## mb0   29 23849 24044 -11896    23791     0  2          1
```

Result

Controlling for their isolated effects and all pairwise 2-way interactions, there is no three-way interaction of group, agent_state, and ascription, $\chi^2(2) = 0$, $p = 1$.

Interaction of Group x Agent State




```
#mb2 = lmer('infelicity ~ group:ascription + agent_state:ascription + (agent_state + ascription|item) +
#grpxagnt <- anova(mb1, mb2)
#saveRDS(grpxagnt, "grpxagnt_fel.rda")
grpxagnt <- readRDS("grpxagnt_fel.rda")
grpxagnt
```

```
## Data: df
## Models:
## mb2: "infelicity ~ group:ascription + agent_state:ascription + (agent_state + ascription|item) + (ag
## mb1: "infelicity ~ group:agent_state + group:ascription + agent_state:ascription + (agent_state + as
##     npar   AIC   BIC logLik deviance  Chisq Df Pr(>Chisq)
## mb2   25 24017 24185 -11983    23967
## mb1   27 23845 24027 -11896    23791 175.55  2  < 2.2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```
# Post-hoc tests for the interaction of group and agent
mb1_post <- emmeans(mb1, specs=pairwise ~ group:agent_state, pbkrtest.limit = 6120)
```

```
## fixed-effect model matrix is rank deficient so dropping 1 column / coefficient
```

```
## boundary (singular) fit: see help('isSingular')
```

```
mb1_post$contrast
```

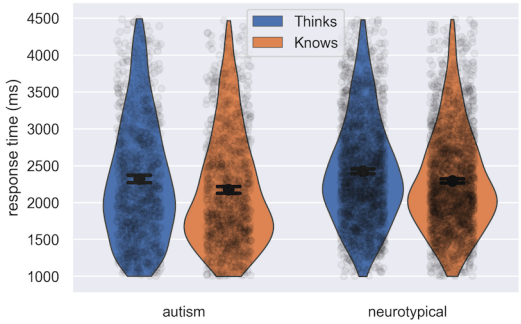
```
##  contrast                                          estimate     SE    df t.ratio
##  autism,False Info - neurotypical,False Info         2.5561 0.1558 620.0  16.403
##  autism,False Info - autism,Ignorance                0.2817 0.0918  85.0   3.068
##  autism,False Info - neurotypical,Ignorance          2.4848 0.1551 400.1  16.025
```

```
##  autism,False Info - autism,True Info               3.2535 0.1550 361.8  20.989
##  autism,False Info - neurotypical,True Info         3.1463 0.1391 315.6  22.625
##  neurotypical,False Info - autism,Ignorance        -2.2745 0.1546 389.8 -14.710
##  neurotypical,False Info - neurotypical,Ignorance  -0.0713 0.0658  25.8  -1.085
##  neurotypical,False Info - autism,True Info         0.6973 0.1216 226.4   5.735
##  neurotypical,False Info - neurotypical,True Info   0.5902 0.1173 176.4   5.030
##  autism,Ignorance - neurotypical,Ignorance          2.2032 0.1538 620.4  14.328
##  autism,Ignorance - autism,True Info                2.9718 0.1499 237.1  19.831
##  autism,Ignorance - neurotypical,True Info          2.8647 0.1376 199.0  20.812
##  neurotypical,Ignorance - autism,True Info          0.7687 0.1205 136.6   6.379
##  neurotypical,Ignorance - neurotypical,True Info    0.6615 0.1133 102.8   5.841
##  autism,True Info - neurotypical,True Info         -0.1072 0.0879 623.4  -1.220
##  p.value
##  <.0001
##  0.0333
##  <.0001
##  <.0001
##  <.0001
##  <.0001
##  0.8830
##  <.0001
##  <.0001
##  <.0001
##  <.0001
##  <.0001
##  <.0001
##  <.0001
##  0.8273
##
## Results are averaged over the levels of: ascription
## Degrees-of-freedom method: kenward-roger
## P value adjustment: tukey method for comparing a family of 6 estimates
```

Result

Controling for the interaction of group x ascription, and the interaction of agent x ascription, there is a significant interaction of group x agent state, $\chi^2(2) = 175.547$, $p = 0$ such that participants in the autism group judged mental state ascriptions more infelicitious than neurotypical participants when the agent was in fact ignorant ($M_{\text{infelicity}}$(Group=ASD, Agent=Ignorant)=4.52, *SD*~infelicity - Ignorant/ASD~=NA vs. *M*~infelicity - Ignorant/NT~=2.41, *SD*~infelicity - Ignorant/NT~=NA) or had false information (*M*~infelicity - FalseInfo/ASD~=4.86, *SD*~infelicity - FalseInfo/ASD~=NA vs. *M*~infelicity - FalseInfo/NT~=2.32, *SD*~infelicity - FalseInfo/NT~=NA)

Interaction of Group x Ascription




```
#mb3 <- lmer('rt ~ group:agent_state + agent_state:ascription + infelicity + (agent_state + ascription|
#grpxascrpt <- anova(mb1, mb3)
#saveRDS(grpxascrpt, "grpxascrpt.rda")
grpxascrpt <- readRDS("grpxascrpt.rda")
grpxascrpt
```

```
## Data: df
## Models:
## mb3: "rt ~ group:agent_state + agent_state:ascription + infelicity + (agent_state + ascription|item)
## mb1: "rt ~ group:agent_state + group:ascription + agent_state:ascription + infelicity + (agent_state
##     npar   AIC   BIC logLik deviance  Chisq Df Pr(>Chisq)
## mb3   27 96648 96829 -48297    96594
## mb1   28 96650 96838 -48297    96594 0.1354  1     0.7129
```

Result

Controlling for the interaction of agent state x group, and the interaction of agent state x ascription, there is no significant interaction of group x ascription, $\chi^2(2) = 0.135$, $p = 0.713$

Interaction of Agent State & Ascription across groups


```
#mb4 <- lmer('rt ~ group:agent_state + group:ascription + infelicity + (agent_state + ascription|item)
#agntxascrpt<-anova(mb1, mb4)
#saveRDS(agntxascrpt, 'agntxascrpt.rda')
```

```
agntxascrpt <- readRDS('agntxascrpt.rda')
agntxascrpt
```

```
## Data: df
## Models:
## mb4: "rt ~ group:agent_state + group:ascription + infelicity + (agent_state + ascription|item) + (ag
## mb1: "rt ~ group:agent_state + group:ascription + agent_state:ascription + infelicity + (agent_state
##     npar   AIC   BIC logLik deviance  Chisq Df Pr(>Chisq)
## mb4   26 96664 96839 -48306    96612
## mb1   28 96650 96838 -48297    96594 18.484  2  9.689e-05 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

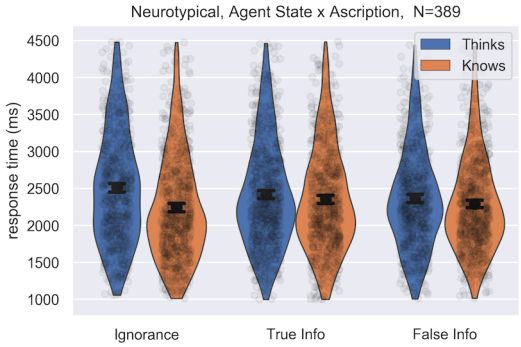
Result

Controlling for the interaction of group x agent state, and the interaction of group x ascription, there is a significant interaction of agent state and ascription across groups, $\chi^2(2) = 18.484$, $p = 10^{-4}$.

Within Group - Neurotypical

```
NT<- df[df$group == "neurotypical",]
```

Interaction of Agent State x Ascription in Neurotypical Group




```
mn0 <- lmer('rt ~ ascription*agent_state + infelicity + (agent_state + ascription|item) + (agent_state|s
```

```
## boundary (singular) fit: see help('isSingular')
```

```
mn1 <- lmer('rt ~ ascription + agent_state + infelicity + (agent_state + ascription|item) + (agent_state
```

```
## boundary (singular) fit: see help('isSingular')
```

```
#ascrptxagnt_nt <- anova(mn0, mn1)
#saveRDS(ascrptxagnt_nt, "ascrptxagnt_nt.rda")
ascrptxagnt_nt <- readRDS("ascrptxagnt_nt.rda")
ascrptxagnt_nt
```

```
## Data: NT
## Models:
```

```
## mn1: rt ~ ascription + agent_state + infelicity + (agent_state + ascription | item) + (agent_state |
## mn0: rt ~ ascription * agent_state + infelicity + (agent_state + ascription | item) + (agent_state |
##     npar   AIC   BIC logLik deviance  Chisq Df Pr(>Chisq)
## mn1   22 63167 63305 -31561    63123
## mn0   24 63142 63293 -31547    63094 28.742  2  5.738e-07 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```
library(emmeans)
library(magrittr)
mn0_post <- emmeans(mn0, specs=pairwise ~ ascription:agent_state, pbkrtest.limit = 4049)
```

```
## boundary (singular) fit: see help('isSingular')
```

```
mn0_post$contrasts
```

```
##  contrast                              estimate   SE   df t.ratio p.value
##  Knows,False Info - Thinks,False Info    -94.2 37.5 32.4 -2.510  0.1508
##  Knows,False Info - Knows,Ignorance       66.1 45.8 19.3  1.443  0.7018
##  Knows,False Info - Thinks,Ignorance    -213.6 66.0 14.0 -3.235  0.0542
##  Knows,False Info - Knows,True Info      -64.1 50.7 19.1 -1.263  0.8004
##  Knows,False Info - Thinks,True Info    -144.9 70.7 13.8 -2.049  0.3655
##  Thinks,False Info - Knows,Ignorance     160.3 34.0 14.4  4.721  0.0033
##  Thinks,False Info - Thinks,Ignorance   -119.4 47.3 22.0 -2.522  0.1605
##  Thinks,False Info - Knows,True Info      30.1 36.7 14.6  0.822  0.9586
##  Thinks,False Info - Thinks,True Info    -50.7 50.9 19.3 -0.996  0.9138
##  Knows,Ignorance - Thinks,Ignorance     -279.7 38.4 35.8 -7.288  <.0001
##  Knows,Ignorance - Knows,True Info      -130.2 41.7 23.2 -3.121  0.0478
##  Knows,Ignorance - Thinks,True Info     -211.0 50.8 14.2 -4.155  0.0098
##  Thinks,Ignorance - Knows,True Info      149.5 46.1 15.1  3.242  0.0505
##  Thinks,Ignorance - Thinks,True Info      68.7 42.3 24.7  1.624  0.5916
##  Knows,True Info - Thinks,True Info      -80.8 37.2 31.6 -2.174  0.2780
##
## Degrees-of-freedom method: kenward-roger
## P value adjustment: tukey method for comparing a family of 6 estimates
```

Result

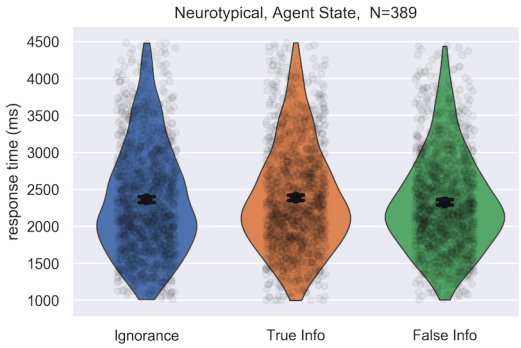
Controlling for their isolated effects, there is a significant interaction of ascription x agent state in the neurotypical group, $\chi^2(2) = 28.742$, $p = 0$.

Post-Hoc tests reveal the participants in the neurotypical group are significantly faster at evaluating attributions of knowledge (M_{rt}=2242.87ms, SD_{rt}=716.41) than attributions of beliefs (M_{rt}=2511.42ms, SD_{rt}=762.56) for agents that are ignorant, $t(35.8)$=-7.288, p<.0001.

Furthermore, knowledge attributions to ignorant agents were also significantly faster than knowledge (M_{rt}=2353.95ms, SD_{rt}=711.15) and belief (M_{rt}=2418.24ms, SD_{rt}=722.59) attributions for agents with true information, t(23.2)=-3.21, p=.048 & t(14.2)=-4.16, p=.009 respectively.

Although this suggests an effect of ignorance on response times in this group, knowledge attributions to agents with true information (M_{rt}=2353.95ms, SD_{rt}=711.15) were, nonetheless, faster than belief attributions to ignorant agents (M_{rt}=2511.42ms, SD_{rt}=762.56), t(15.1)=3.24, p=.05.

Main Effect of Agent State in Neurotypical Group



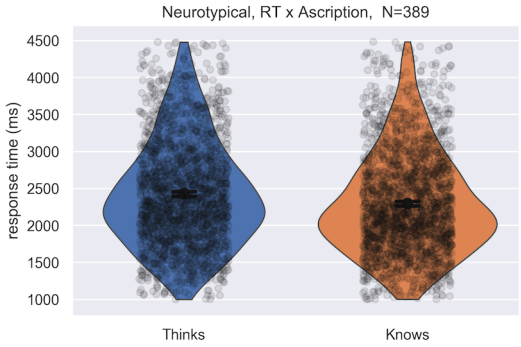

```
#mn2 <- lmer('rt ~ ascription  + infelicity + (agent_state + ascription|item) + (agent_state|subject) '
#agnt_nt <- anova(mn1, mn2)
#saveRDS(agnt_nt, "agnt_nt.rda")
agnt_nt <- readRDS("agnt_nt.rda")
agnt_nt
```

```
## Data: NT
## Models:
## mn2: "rt ~ ascription  + infelicity + (agent_state + ascription|item) + (agent_state|subject) "
## mn1: "rt ~ ascription + agent_state + infelicity + (agent_state + ascription|item) + (agent_state|su
##     npar   AIC   BIC logLik deviance  Chisq Df Pr(>Chisq)
## mn2   20 63164 63290 -31562    63124
## mn1   22 63167 63305 -31561    63123 1.4847  2      0.476
```

Result

There is no main effect of agent state on response times in the neurotypical group, $\chi^2(2) = 1.485$, $p = 0.476$

Main Effect of Ascription in Neurotypical Group




```
#mn3 <- lmer('rt ~ agent_state  + infelicity + (agent_state + ascription|item) + (agent_state|subject)
#ascrpt_nt <- anova(mn1, mn3)
#saveRDS(ascrpt_nt, "ascrpt_nt.rda")
ascrpt_nt <- readRDS("ascrpt_nt.rda")
ascrpt_nt
```

```
## Data: NT
## Models:
## mn3: rt ~ agent_state + infelicity + (agent_state + ascription | item) + (agent_state | subject)
## mn1: rt ~ ascription + agent_state + infelicity + (agent_state + ascription | item) + (agent_state |
##     npar   AIC   BIC logLik deviance  Chisq Df Pr(>Chisq)
## mn3   21 63180 63312 -31569    63138
## mn1   22 63167 63305 -31561    63123 15.035  1  0.0001056 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

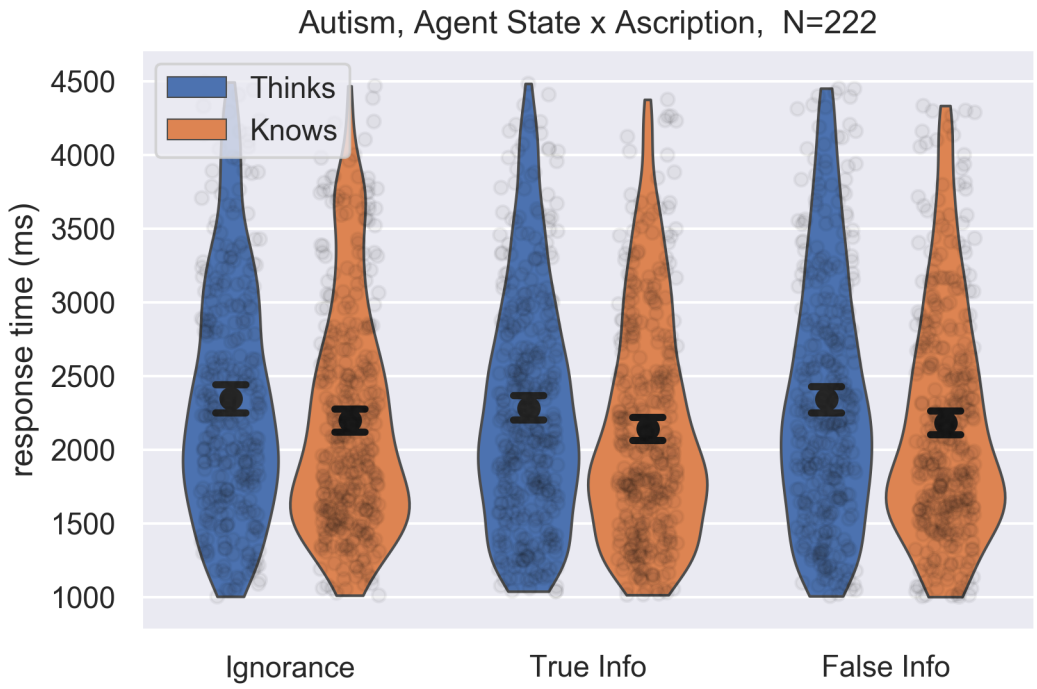
Result

Controlling for agent state and infelicity, participants in the neurotypical group are faster at attributing knowledge (M_{rt}=2295.04ms, SD_{rt}=693.78) than beliefs (M_{rt}=2429.38ms, SD_{rt}=724.65) to other agents, $\chi^2(2) = 15.035$, $p = 0$

Within Group - Autism

```
ASD <- df[df$group == "autism",]
```

Interaction of Agent State x Ascription - Autism




```
#ma0 <- lmer('rt ~ ascription*agent_state + infelicity + (agent_state + ascription|item) + (agent_state
#ma1 <- lmer('rt ~ ascription + agent_state + infelicity + (agent_state + ascription|item) + (agent_sta
```

```
#ascrptxagnt_asd <- anova(ma0, ma1)
#saveRDS(ascrptxagnt_asd, "ascrptxagnt_asd.rda")
ascrptxagnt_asd <- readRDS("ascrptxagnt_asd.rda")
ascrptxagnt_asd
```

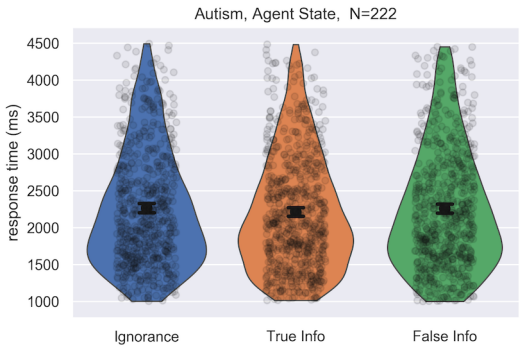
```
## Data: ASD
## Models:
## ma1: "rt ~ ascription + agent_state + infelicity + (agent_state + ascription|item) + (agent_state|su
## ma0: "rt ~ ascription*agent_state + infelicity + (agent_state + ascription|item) + (agent_state|subj
##     npar   AIC   BIC logLik deviance  Chisq Df Pr(>Chisq)
## ma1   22 33320 33444 -16638    33276
## ma0   24 33324 33460 -16638    33276 0.2341  2     0.8895
```

```
#library (emmeans)
#library(magrittr)
#ma0_post <- emmeans(ma0, specs=pairwise ~ ascription:agent_state, pbkrtest.limit = 4049)
#ma0_post$contrasts
```

Result

Controlling for infelicity, there is no agent state x ascription interaction in the autism group, $\chi^2(2) = 0.234$, $p = 0.89$

Main Effect of Agent State in ASD Group



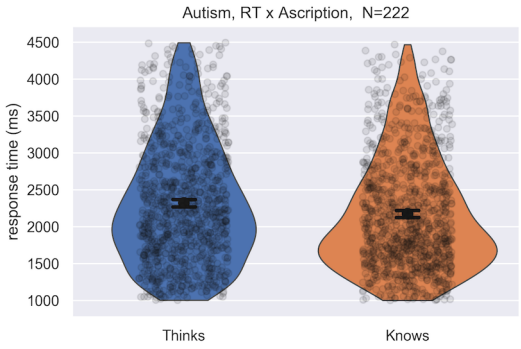

```
#ma2 <- lmer('rt ~ ascription  + infelicity + (agent_state + ascription|item) + (agent_state|subject) '
#agnt_asd <- anova(ma1, ma2)
#saveRDS(agnt_asd, "agnt_asd.rda")
agnt_asd <- readRDS("agnt_asd.rda")
agnt_asd
```

```
## Data: ASD
## Models:
## ma2: "rt ~ ascription  + infelicity + (agent_state + ascription|item) + (agent_state|subject) "
## ma1: "rt ~ ascription + agent_state + infelicity + (agent_state + ascription|item) + (agent_state|su
##     npar   AIC   BIC logLik deviance  Chisq Df Pr(>Chisq)
## ma2   20 33320 33433 -16640    33280
## ma1   22 33320 33444 -16638    33276 3.9998  2     0.1353
```

Result

Controlling for infelicity, there is no effect of agent state on RT in the autism group, $\chi^2(2) = 4$, $p = 0.135$

Main Effect of Ascription in Autism Group




```
#ma3 <- lmer('rt ~ agent_state  + infelicity + (agent_state + ascription|item) + (agent_state|subject)
#ascrpt_asd <- anova(ma1, ma3)
#saveRDS(ascrpt_asd, "ascrpt_asd.rda")
ascrpt_asd <- readRDS("ascrpt_asd.rda")
ascrpt_asd
```

```
## Data: ASD
## Models:
## ma3: "rt ~ agent_state  + infelicity + (agent_state + ascription|item) + (agent_state|subject) "
## ma1: "rt ~ ascription + agent_state + infelicity + (agent_state + ascription|item) + (agent_state|su
##     npar   AIC   BIC logLik deviance  Chisq Df Pr(>Chisq)
## ma3   21 33333 33451 -16645    33291
## ma1   22 33320 33444 -16638    33276 14.099  1  0.0001734 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

Result

Controlling for agent state and infelicity, there is a significant effect of ascription in the autism group such that knowledge ascriptions (M_{rt}=2174.51ms, SD_{rt}=771.54) are made significantly faster than belief ascriptions (M_{rt}=2321.68ms, SD_{rt}=823.27), $\chi^2(2) = 14.099$, $p = 0$