

# Networks Retrieval Study

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## 1 Reading the Data File

```
> net = read.csv("CompiledData_E4.csv", header = TRUE, sep = ",")
> #net = net %>% filter(!Subject %in% c(5, 1, 2, 6, 3, 7))
```

## 2 Item Analysis

```
> library(dplyr)
> net_itemacc = group_by(net, ActualTarget) %>%
+   summarize_at(vars(TargetAccuracy), mean) %>%
+   arrange(TargetAccuracy)
> net_primeitem_acc = group_by(net, ActualPrime, ActualTarget) %>%
+   summarize_at(vars(PrimeFirstResp_ACC), mean) %>%
+   arrange(ActualTarget, PrimeFirstResp_ACC)
> net_primeitem_acc = net_primeitem_acc %>% filter(PrimeFirstResp_ACC ≤ 0.1 |
+   PrimeFirstResp_ACC == "1")
> overall_sub_acc = group_by(net, Subject) %>%
+   summarize_at(vars(TargetAccuracy), mean)
>
```

## 3 Figures

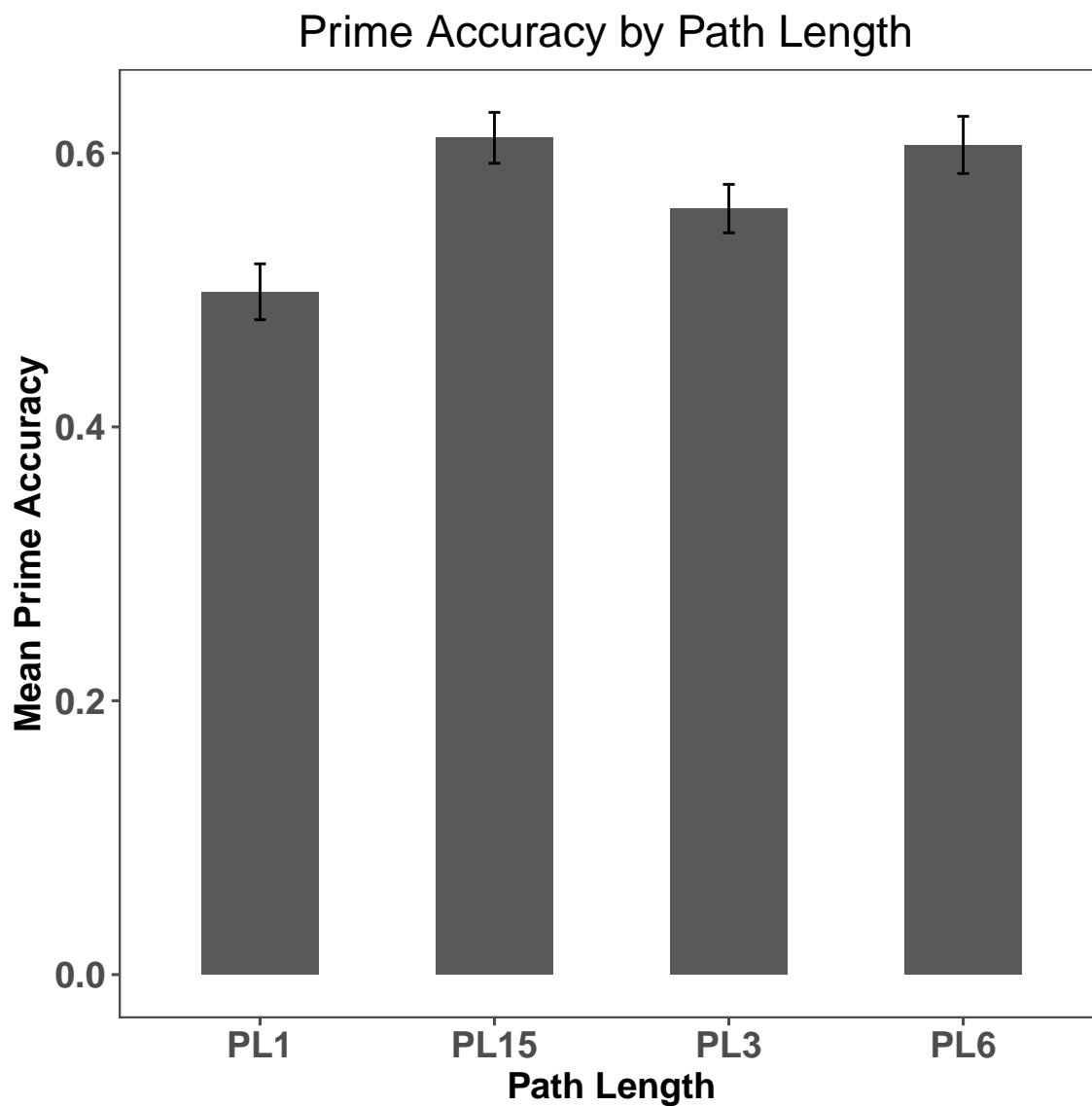
### 3.1 Prime Accuracy

```
> net_primeacc = group_by(net, Subject, pathlength) %>%
+   summarize_at(vars(PrimeFirstResp_ACC), mean)
> netprime_rmisc = Rmisc::summarySE(net_primeacc,
+   measurevar = "PrimeFirstResp_ACC",
+   groupvars = c("pathlength"))
> netprime_rmisc$pathlength = as.factor(netprime_rmisc$pathlength)
> library(ggplot2)
> library(ggthemes)
> netprime_rmisc %>%
```

```

+ ggplot(aes(x = pathlength,
+           y = PrimeFirstResp_ACC))+
+   geom_bar(stat = "identity", position = "dodge",
+           width = 0.5)+
+   geom_errorbar(aes(ymin = PrimeFirstResp_ACC - se,
+                     ymax = PrimeFirstResp_ACC + se),
+                 width=.05, position=position_dodge(.5)) +
+   theme_few()+
+   scale_fill_wsj()+
+   xlab("Path Length") + ylab("Mean Prime Accuracy") +
+   ggtitle("Prime Accuracy by Path Length ") +
+   theme(axis.text = element_text(face = "bold", size = rel(1.2)),
+         axis.title = element_text(face = "bold", size = rel(1.2)),
+         legend.title = element_text(face = "bold", size = rel(1.2)),
+         plot.title = element_text( size = rel(1.4), hjust = .5))
>

```



### 3.2 Target Accuracy

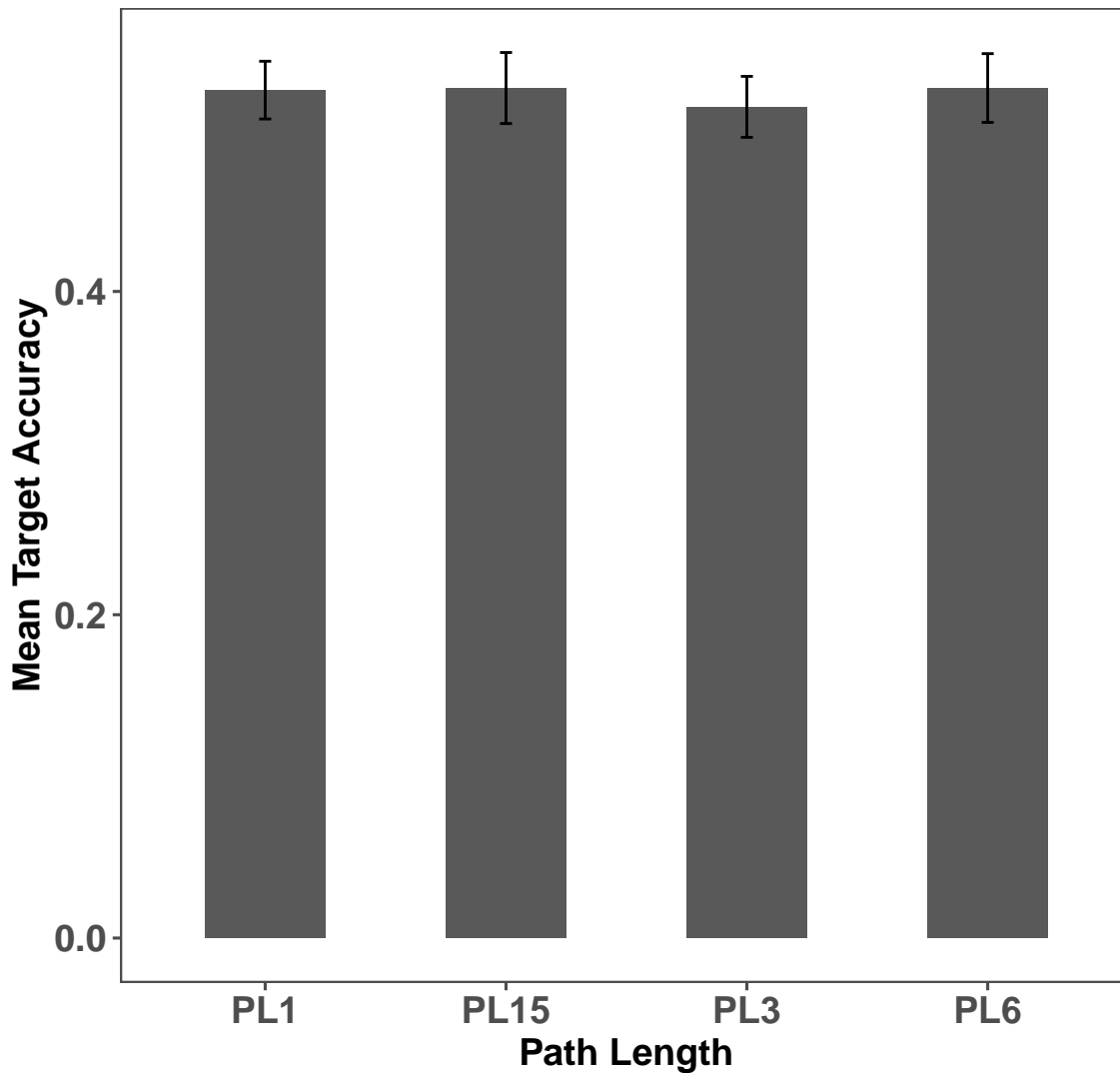
```
> net_targetacc = group_by(net, Subject, pathlength) %>%  
+   summarize_at(vars(TargetAccuracy), mean)  
> nettarget_rmisc = Rmisc::summarySE(net_targetacc,  
+                                     measurevar = "TargetAccuracy",  
+                                     groupvars = c("pathlength"))  
> nettarget_rmisc$pathlength = as.factor(nettarget_rmisc$pathlength)  
> library(ggplot2)  
> library(ggthemes)
```

```

> nettarget_rmisc %>%
+ ggplot(aes(x = pathlength,
+           y = TargetAccuracy))+
+   geom_bar(stat = "identity", position = "dodge",
+           width = 0.5)+
+   geom_errorbar(aes(ymin = TargetAccuracy - se,
+                     ymax = TargetAccuracy + se),
+                 width=.05, position=position_dodge(.5)) +
+   theme_few()+
+   scale_fill_ws()+
+   xlab("Path Length") + ylab("Mean Target Accuracy") +
+   ggtitle("Target Accuracy by Path Length") +
+   theme(axis.text = element_text(face = "bold", size = rel(1.2)),
+         axis.title = element_text(face = "bold", size = rel(1.2)),
+         legend.title = element_text(face = "bold", size = rel(1.2)),
+         plot.title = element_text( size = rel(1.4), hjust = .5))
>

```

Target Accuracy by Path Length



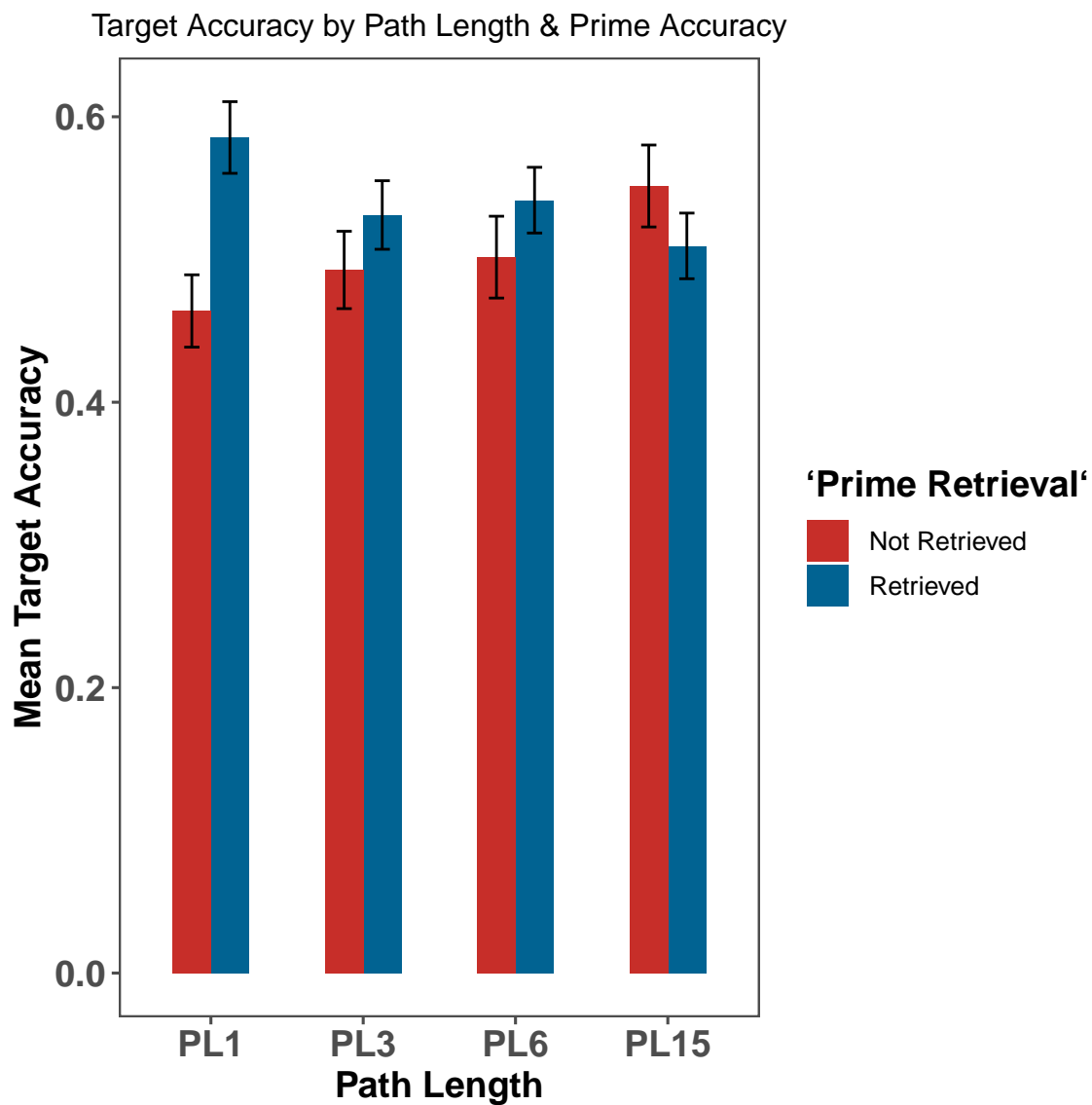
### 3.3 Prime Retrieval

```
> net_subject = group_by(net, Subject, pathlength, PrimeFirstResp_ACC) %>%
+   summarize_at(vars(TargetAccuracy), mean)
> net_rmisc = Rmisc::summarySE(net,
+                               measurevar = "TargetAccuracy",
+                               groupvars = c("pathlength", "PrimeFirstResp_ACC"))
> net_rmisc$PrimeFirstResp_ACC = as.factor(net_rmisc$PrimeFirstResp_ACC)
> net_rmisc$pathlength = as.factor(net_rmisc$pathlength)
> net_rmisc$pathlengthfac = ordered(as.factor(as.character(net_rmisc$pathlength))),
```

```

+               levels = c("PL1", "PL3", "PL6", "PL15"))
> library(ggplot2)
> library(ggthemes)
> net_rmisc %>% mutate(`Prime Retrieval` = factor(PrimeFirstResp_ACC,
+               levels = unique(PrimeFirstResp_ACC),
+               labels = c("Not Retrieved", "Retrieved")))%>%
+ ggplot(aes(x = pathlengthfac,
+           y = TargetAccuracy,
+           fill = `Prime Retrieval`, group = `Prime Retrieval`))+
+ geom_bar(stat = "identity", position = "dodge",
+         width = 0.5)+
+ geom_errorbar(aes(ymin = TargetAccuracy - se,
+                 ymax = TargetAccuracy + se),
+               width=.2, position=position_dodge(.5)) +
+ theme_few()+
+ scale_fill_wsj()+
+ xlab("Path Length") + ylab("Mean Target Accuracy") +
+ ggtitle("Target Accuracy by Path Length & Prime Accuracy") +
+   theme(axis.text = element_text(face = "bold", size = rel(1.2)),
+         axis.title = element_text(face = "bold", size = rel(1.2)),
+         legend.title = element_text(face = "bold", size = rel(1.2)),
+         plot.title = element_text( size = rel(1), hjust = .5))
>

```



## 4 AOV

### 4.1 Target Accuracy

```
> net_targetacc$Subject = as.factor(net_targetacc$Subject)
> net_targetacc$pathlength = as.factor(net_targetacc$pathlength)
> targetacc_aov = aov(data = net_targetacc, TargetAccuracy ~ pathlength +
+                      Error(Subject/pathlength))
> summary(targetacc_aov)
```

```
Error: Subject
      Df Sum Sq Mean Sq F value Pr(>F)
Residuals 42  1.676  0.0399
```

```
Error: Subject:pathlength
      Df Sum Sq Mean Sq F value Pr(>F)
pathlength  3 0.0041 0.001364  0.139  0.936
Residuals 126 1.2320 0.009778
```

## 4.2 Prime Accuracy

```
> net_primeacc$Subject = as.factor(net_primeacc$Subject)
> net_primeacc$pathlength = as.factor(net_primeacc$pathlength)
> primeacc_aov = aov(data = net_primeacc, PrimeFirstResp_ACC ~ pathlength +
+                      Error(Subject/pathlength))
> summary(primeacc_aov)
```

```
Error: Subject
      Df Sum Sq Mean Sq F value Pr(>F)
Residuals 42  1.441 0.03432
```

```
Error: Subject:pathlength
      Df Sum Sq Mean Sq F value Pr(>F)
pathlength  3 0.3513  0.1171  11.48 1.05e-06 ***
Residuals 126 1.2852  0.0102
```

```
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

## 4.3 Effect of Retrieval

```
> net_subject$pathlength = as.factor(net_subject$pathlength)
> net_subject$Subject = as.factor(net_subject$Subject)
> net_subject$PrimeFirstResp_ACC = as.factor(net_subject$PrimeFirstResp_ACC)
> ## AOV
> retrieval_aov = aov(data = net_subject,
+                      TargetAccuracy ~ PrimeFirstResp_ACC*pathlength +
+                      Error(Subject/(PrimeFirstResp_ACC*pathlength)))
> summary(retrieval_aov)
```

```
Error: Subject
      Df Sum Sq Mean Sq F value Pr(>F)
Residuals 42  3.18 0.07571
```

```
Error: Subject:PrimeFirstResp_ACC
      Df Sum Sq Mean Sq F value Pr(>F)
```



```

PrimeFirstResp_ACC  1 0.0157 0.01568    0.519    0.475
Residuals          42 1.2694 0.03022

Error: Subject:pathlength
      Df Sum Sq Mean Sq F value Pr(>F)
pathlength    3 0.0146 0.00488    0.217  0.884
Residuals   126 2.8318 0.02247

Error: Subject:PrimeFirstResp_ACC:pathlength
      Df Sum Sq Mean Sq F value Pr(>F)
PrimeFirstResp_ACC:pathlength    3  0.296 0.09868    2.515 0.0614 .
Residuals          126  4.944 0.03924
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

```

```

> ## LMER
>
> net$pathlength = as.factor(net$pathlength)
> net$Subject = as.factor(net$Subject)
> net$PrimeFirstResp_ACC = as.factor(net$PrimeFirstResp_ACC)
> library(optimx)
> library(lme4)
> retrieval_model = glmer(data = net, TargetAccuracy ~ pathlength*PrimeFirstResp_ACC +
+ (1|Subject) + (1|Stimuli1), family = "binomial",
+ control = glmerControl(optimizer = "optimx",
+ calc.derivs = FALSE,
+ optCtrl = list(method = "nlminb", starttests = FALSE, kkt = FALSE)))
> summary(retrieval_model)

```

```

Generalized linear mixed model fit by maximum likelihood (Laplace
Approximation) [glmerMod]
Family: binomial ( logit )
Formula: TargetAccuracy ~ pathlength * PrimeFirstResp_ACC + (1 | Subject) +
(1 | Stimuli1)
Data: net
Control:
glmerControl(optimizer = "optimx", calc.derivs = FALSE, optCtrl = list(method = "nlminb",
starttests = FALSE, kkt = FALSE))

      AIC      BIC    logLik deviance df.resid
3445.9   3506.3  -1712.9   3425.9     3086

Scaled residuals:
    Min       1Q   Median       3Q      Max
-4.3546 -0.6576  0.2093  0.6493  3.7166

Random effects:
Groups   Name              Variance Std.Dev.

```

```

Stimuli1 (Intercept) 2.3380    1.5290
Subject   (Intercept) 0.2451    0.4951
Number of obs: 3096, groups: Stimuli1, 72; Subject, 43

Fixed effects:
                Estimate Std. Error z value Pr(>|z|)
(Intercept)      -0.04948    0.23296  -0.212   0.83181
pathlengthPL15     0.29431    0.18747   1.570   0.11644
pathlengthPL3      0.07359    0.18381   0.400   0.68887
pathlengthPL6      0.13613    0.18458   0.738   0.46081
PrimeFirstResp_ACC1 0.47440    0.18249   2.600   0.00933 **
pathlengthPL15:PrimeFirstResp_ACC1 -0.61867    0.25856  -2.393   0.01672 *
pathlengthPL3:PrimeFirstResp_ACC1 -0.33634    0.25815  -1.303   0.19261
pathlengthPL6:PrimeFirstResp_ACC1 -0.30198    0.25820  -1.170   0.24218
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Correlation of Fixed Effects:
      (Intr) ptPL15 pthPL3 pthPL6 PFR_AC pPL15: pPL3:P
pthlngtPL15 -0.357
pthlngthPL3 -0.367  0.454
pthlngthPL6 -0.360  0.448  0.468
PrmFrR_ACC1 -0.390  0.480  0.491  0.488
pPL15:PFR_A  0.272 -0.758 -0.344 -0.341 -0.699
pPL3:PFR_AC  0.275 -0.339 -0.747 -0.353 -0.703  0.492
pPL6:PFR_AC  0.269 -0.334 -0.354 -0.749 -0.700  0.489  0.505

```

```
> car::Anova(retrieval_model)
```

```
Analysis of Deviance Table (Type II Wald chisquare tests)
```

```
Response: TargetAccuracy
```

```

                Chisq Df Pr(>Chisq)
pathlength      0.7245  3   0.86744
PrimeFirstResp_ACC 2.9985  1   0.08334 .
pathlength:PrimeFirstResp_ACC 5.7492  3   0.12447
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

```

## 5 Demasking RTs

```

> library(dplyr)
> net_firsttrim_target = subset(net,
+                               net$RTrecogniseTarget > 250 &
+                               net$RTrecogniseTarget < 7000)
> net_firsttrim_prime = subset(net,

```

```

+                               net$RTrecognisePrime > 250 &
+                               net$RTrecognisePrime < 7000)
> net_firstttrim_targetdef = subset(net,
+                               net$TargetDefRT > 250 &
+                               net$TargetDefRT < 9000)

```

## RTRecogniseprime

```

> ## FOR PRIME
> ## aggregate per subject all IVs and DVs
> meanRT = group_by(net_firstttrim_prime, Subject) %>%
+   summarise_at(vars(RTrecognisePrime), mean)
> colnames(meanRT) = c("Subject",
+   "MeanRTrecogPrime")
> sdRT = group_by(net_firstttrim_prime, Subject) %>%
+   summarise_at(vars(RTrecognisePrime), sd)
> colnames(sdRT) = c("Subject",
+   "sdRTrecogPrime")
> RT_agg = merge(meanRT, sdRT, by = "Subject")
> ## merge aggregate info with long data
> net_z_prime = merge(net_firstttrim_prime,
+   RT_agg, by = "Subject", all.x = T)
> ## person and grand-mean centered scores using original and aggregate
> library(dplyr)
> net_z_prime = net_z_prime %>% mutate(zPrimeRecogRT =
+   (RTrecognisePrime -
+   MeanRTrecogPrime)/sdRTrecogPrime)
> ## checking: subject level means should be zero
>
> sub_pic = group_by(net_z_prime, Subject) %>%
+   summarise_at(vars(zPrimeRecogRT), mean)

```

## RTRecogniseTarget

```

> ## FOR TARGET
> ## aggregate per subject all IVs and DVs
> meanRT = group_by(net_firstttrim_target, Subject) %>%
+   summarise_at(vars(RTrecogniseTarget), mean)
> colnames(meanRT) = c("Subject", "MeanRTrecogTarget")
> sdRT = group_by(net_firstttrim_target, Subject) %>%
+   summarise_at(vars(RTrecogniseTarget), sd)
> colnames(sdRT) = c("Subject", "sdRTrecogTarget")
> RT_agg = merge(meanRT, sdRT, by = "Subject")
> ## merge aggregate info with long data
> net_z_target= merge(net_firstttrim_target,
+   RT_agg, by = "Subject", all.x = T)

```

```

> ## person and grand-mean centered scores using original and aggregate
> library(dplyr)
> net_z_target = net_z_target %>% mutate( zTargetRecogRT =
+                                         (RTrecogniseTarget -
+                                         MeanRTrecogTarget)/sdRTrecogTarget)
> ## checking: subject level means should be zero
>
> sub_pic = group_by(net_z_target, Subject) %>%
+   summarise_at(vars(zTargetRecogRT), mean)
>

```

## 6 Trimming z-RTs

```

> net_z_trimmed_prime = subset(net_z_prime,
+                               net_z_prime$zPrimeRecogRT < 3 &
+                               net_z_prime$zPrimeRecogRT > -3)
> net_z_trimmed_target = subset(net_z_target,
+                                net_z_target$zTargetRecogRT < 3 &
+                                net_z_target$zTargetRecogRT > -3)
>

```

## 7 Repeating z-scoring

### 7.1 For prime

```

> ## aggregate per subject all IVs and DVs
> meanRT_prime = group_by(net_z_trimmed_prime, Subject) %>%
+   summarise_at(vars(RTrecognisePrime), mean)
> colnames(meanRT_prime) = c("Subject",
+                             "MeanRTrecogPrime_trim")
> sdRT_prime = group_by(net_z_trimmed_prime, Subject) %>%
+   summarise_at(vars(RTrecognisePrime), sd)
> colnames(sdRT_prime) = c("Subject",
+                           "sdRTrecogPrime_trim")
> RT_agg_prime = merge(meanRT_prime, sdRT_prime, by = "Subject")
> ## merge aggregate info with long data
> net_final_z_prime = merge(net_z_trimmed_prime,
+                             RT_agg_prime, by = "Subject", all.x = T)
> ## person and grand-mean centered scores using original and aggregate
> library(dplyr)
> net_final_z_prime = net_final_z_prime %>%
+   mutate( zPrimeRecogRT_trim =
+           (RTrecognisePrime -
+           MeanRTrecogPrime_trim)/sdRTrecogPrime_trim)
> ## checking: subject level means should be zero

```

```

>
> sub_pic = group_by(net_final_z_prime, Subject) %>%
+   summarise_at(vars(zPrimeRecogRT_trim), mean)
>

```

## 7.2 For Target

```

> ## aggregate per subject all IVs and DVs
> meanRT_target = group_by(net_z_trimmed_target, Subject) %>%
+   summarise_at(vars(RTrecogniseTarget), mean)
> colnames(meanRT_target) = c("Subject",
+   "MeanRTrecogTarget_trim")
> sdRT_target = group_by(net_z_trimmed_target, Subject) %>%
+   summarise_at(vars(RTrecogniseTarget), sd)
> colnames(sdRT_target) = c("Subject",
+   "sdRTrecogTarget_trim")
> RT_agg_target = merge(meanRT_target, sdRT_target, by = "Subject")
> ## merge aggregate info with long data
> net_final_z_target = merge(net_z_trimmed_target,
+   RT_agg_target, by = "Subject", all.x = T)
> ## person and grand-mean centered scores using original and aggregate
> library(dplyr)
> net_final_z_target = net_final_z_target %>%
+   mutate( zTargetRecogRT_trim =
+   (RTrecogniseTarget -
+   MeanRTrecogTarget_trim)/sdRTrecogTarget_trim)
> ## checking: subject level means should be zero
>
> sub_pic = group_by(net_final_z_target, Subject) %>%
+   summarise_at(vars(zTargetRecogRT_trim), mean)
>

```

## 7.3 Combining z-RT Prime and Target

```

> ## now we have separately z-scored RTprime and RTtarget. Need to combine.
> ## taking only necessary columns
> net_final_z_prime2 = net_final_z_prime[,c(1,4,34)]
> net_final_z = merge(net_final_z_target,
+   net_final_z_prime2,
+   by = c("Subject", "Trial"))
>

```

## 8 Linear Models

```

> # Mean RT to retrieve Target as a function of Prime Condition
>
> # Effect of RT prime on Accuracy
> library(lme4)
> library(lmerTest)
> RTprime_acc_model = glmer(data = net_final_z,
+                           TargetAccuracy ~ zPrimeRecogRT_trim*pathlength +
+                           (1|Subject) + (1|Stimuli1), family = binomial )
> summary(RTprime_acc_model)

```

```

Generalized linear mixed model fit by maximum likelihood (Laplace
Approximation) [glmerMod]
Family: binomial (logit)
Formula: TargetAccuracy ~ zPrimeRecogRT_trim * pathlength + (1 | Subject) +
(1 | Stimuli1)
Data: net_final_z

```

AIC	BIC	logLik	deviance	df.resid
3313.6	3373.5	-1646.8	3293.6	2951

Scaled residuals:

Min	1Q	Median	3Q	Max
-4.1172	-0.6583	0.2228	0.6538	3.2305

Random effects:

Groups	Name	Variance	Std.Dev.
Stimuli1	(Intercept)	2.3598	1.5362
Subject	(Intercept)	0.2553	0.5053

Number of obs: 2961, groups: Stimuli1, 72; Subject, 43

Fixed effects:

	Estimate	Std. Error	z value	Pr(> z )
(Intercept)	0.21224	0.21677	0.979	0.328
zPrimeRecogRT_trim	-0.02109	0.09128	-0.231	0.817
pathlengthPL15	-0.03027	0.12485	-0.242	0.808
pathlengthPL3	-0.05046	0.12532	-0.403	0.687
pathlengthPL6	0.02569	0.12546	0.205	0.838
zPrimeRecogRT_trim:pathlengthPL15	0.02478	0.12756	0.194	0.846
zPrimeRecogRT_trim:pathlengthPL3	0.02917	0.13144	0.222	0.824
zPrimeRecogRT_trim:pathlengthPL6	0.06243	0.13037	0.479	0.632

Correlation of Fixed Effects:

	(Intr)	zPrRRT_	ptPL15	pthPL3	pthPL6	zPRRT_:PL1	zPRRT_:PL3
zPrmRcgRT_t	-0.015						
pthlngtPL15	-0.289	0.026					
pthlngthPL3	-0.289	0.026	0.504				
pthlngthPL6	-0.289	0.025	0.503	0.500			

zPRRT_:PL15	0.012	-0.715	-0.035	-0.018	-0.019		
zPrRRT_:PL3	0.011	-0.701	-0.018	-0.031	-0.018	0.496	
zPrRRT_:PL6	0.014	-0.696	-0.019	-0.018	-0.005	0.495	0.490

```
> car::Anova(RTprime_acc_model)
```

Analysis of Deviance Table (Type II Wald chisquare tests)

Response: TargetAccuracy

	Chisq	Df	Pr(>Chisq)
zPrimeRecogRT_trim	0.0266	1	0.8705
pathlength	0.4172	3	0.9367
zPrimeRecogRT_trim:pathlength	0.2317	3	0.9723

```
> options(contrasts = c("contr.sum","contr.poly"))
> anova(RTprime_acc_model)
```

Analysis of Variance Table

	Df	Sum Sq	Mean Sq	F value
zPrimeRecogRT_trim	1	0.02401	0.024009	0.0240
pathlength	3	0.42412	0.141373	0.1414
zPrimeRecogRT_trim:pathlength	3	0.23466	0.078219	0.0782

```
> RTprime_RT_model = lmer(data = net_final_z,
+                           zTargetRecogRT_trim ~ zPrimeRecogRT_trim*pathlength +
+                           (1|Subject) + (1|Stimuli1) )
> summary(RTprime_RT_model)
```

Linear mixed model fit by REML. t-tests use Satterthwaite's method [lmerModLmerTest]

Formula: zTargetRecogRT\_trim ~ zPrimeRecogRT\_trim \* pathlength + (1 | Subject) + (1 | Stimuli1)  
Data: net\_final\_z

REML criterion at convergence: 7965.8

Scaled residuals:

Min	1Q	Median	3Q	Max
-2.6582	-0.6291	-0.2393	0.4326	4.7551

Random effects:

Groups	Name	Variance	Std.Dev.
Stimuli1	(Intercept)	1.720e-01	4.147e-01
Subject	(Intercept)	1.350e-16	1.162e-08
Residual		8.067e-01	8.982e-01

Number of obs: 2961, groups: Stimuli1, 72; Subject, 43

Fixed effects:

	Estimate	Std. Error	df	t value
(Intercept)	8.453e-04	5.160e-02	6.969e+01	0.016
zPrimeRecogRT_trim	1.325e-01	1.718e-02	2.914e+03	7.709
pathlength1	-3.795e-02	2.867e-02	2.885e+03	-1.324
pathlength2	3.710e-02	2.867e-02	2.884e+03	1.294
pathlength3	-2.992e-02	2.863e-02	2.883e+03	-1.045
zPrimeRecogRT_trim:pathlength1	-2.287e-02	2.931e-02	2.910e+03	-0.780
zPrimeRecogRT_trim:pathlength2	-1.181e-02	2.956e-02	2.915e+03	-0.400
zPrimeRecogRT_trim:pathlength3	-1.730e-02	2.981e-02	2.914e+03	-0.580

Pr(>|t|)

(Intercept)	0.987
zPrimeRecogRT_trim	1.72e-14 ***
pathlength1	0.186
pathlength2	0.196
pathlength3	0.296
zPrimeRecogRT_trim:pathlength1	0.435
zPrimeRecogRT_trim:pathlength2	0.689
zPrimeRecogRT_trim:pathlength3	0.562

---

Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1

Correlation of Fixed Effects:

	(Intr)	zPrRRT_	pthln1	pthln2	pthln3	zPRRT_:1	zPRRT_:2
zPrmRcgRT_t	0.003						
pathlength1	-0.001	-0.029					
pathlength2	0.000	-0.007	-0.334				
pathlength3	-0.001	-0.008	-0.332	-0.331			
zPrmRcRT_:1	-0.010	-0.020	-0.029	0.021	0.018		
zPrmRcRT_:2	-0.003	-0.022	0.020	-0.004	0.007	-0.318	
zPrmRcRT_:3	-0.002	0.001	0.020	0.004	0.001	-0.333	-0.331

```
> car::Anova(RTprime_RT_model)
```

Analysis of Deviance Table (Type II Wald chisquare tests)

Response: zTargetRecogRT\_trim

	Chisq	Df	Pr(>Chisq)
zPrimeRecogRT_trim	58.4674	1	2.067e-14 ***
pathlength	4.0876	3	0.2522
zPrimeRecogRT_trim:pathlength	3.0457	3	0.3846

---

Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1

```
> options(contrasts = c("contr.sum","contr.poly"))
> anova(RTprime_RT_model)
```



```
Type III Analysis of Variance Table with Satterthwaite's method
```

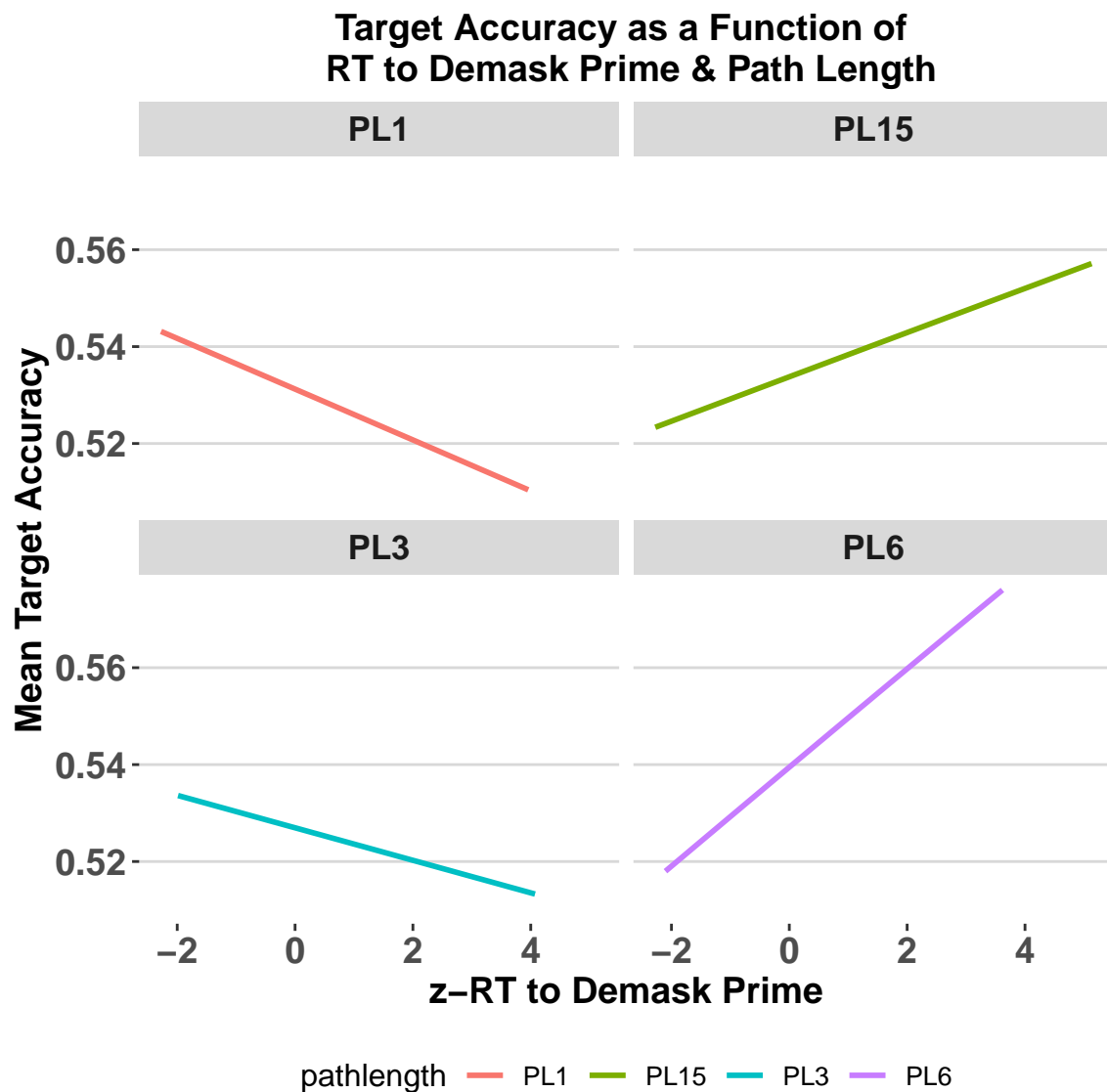
	Sum Sq	Mean Sq	NumDF	DenDF	F value	Pr(>F)
zPrimeRecogRT_trim	47.946	47.946	1	2914.4	59.4344	1.722e-14 ***
pathlength	3.425	1.142	3	2883.9	1.4151	0.2364
zPrimeRecogRT_trim:pathlength	2.457	0.819	3	2912.1	1.0152	0.3848

```
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```
>
```

## 8.1 Acc Figure

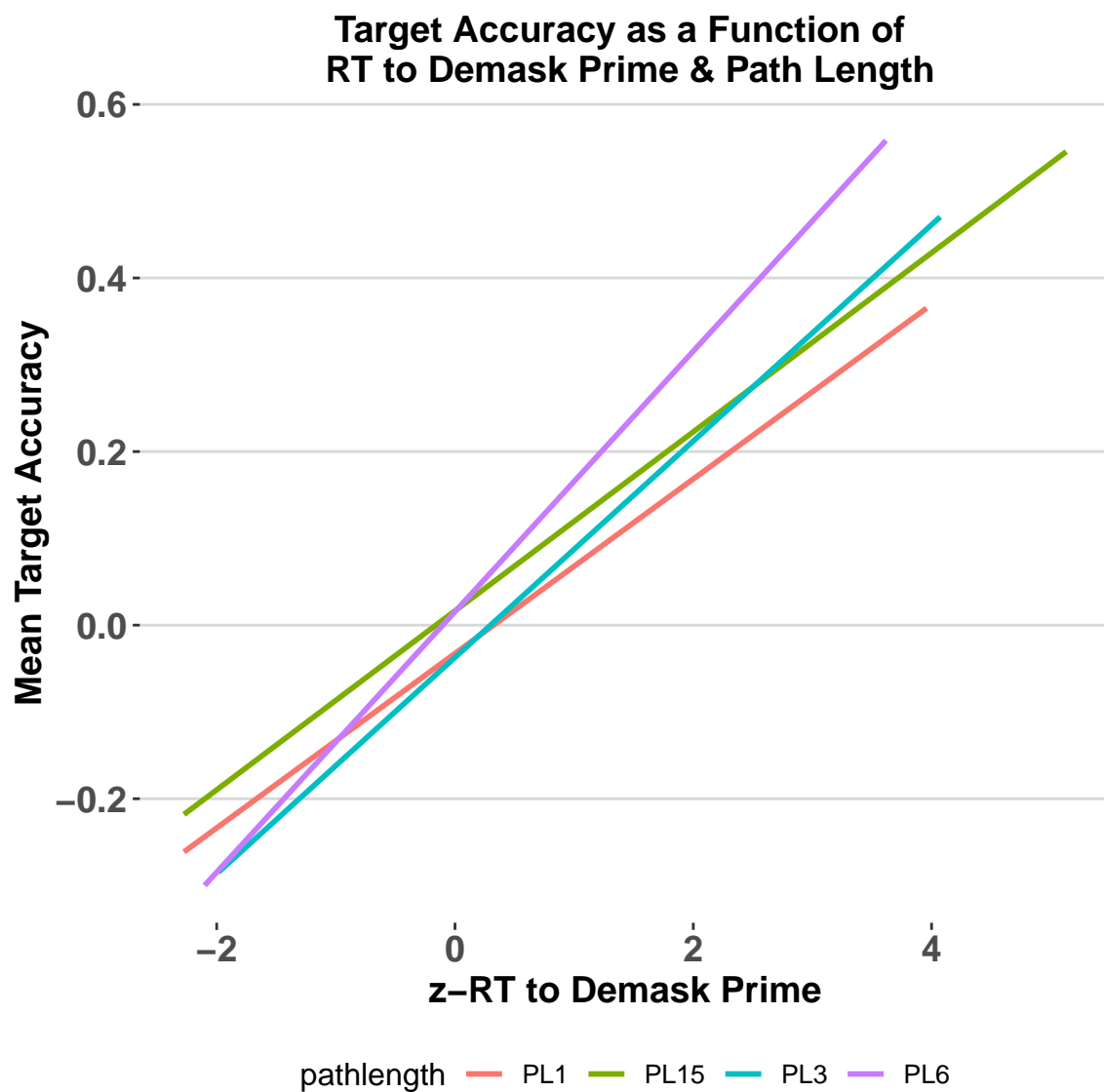
```
> net_final_z %>%
+   ggplot(aes(x = zPrimeRecogRT_trim, y = TargetAccuracy,
+             group = pathlength, color = pathlength)) +
+   geom_smooth(method = "glm", se = FALSE, method.args = list(family = "binomial"))+
+   facet_wrap(~pathlength)+
+   xlab("z-RT to Demask Prime") + ylab ("Mean Target Accuracy")+
+   ggtitle("Target Accuracy as a Function of \n RT to Demask Prime & Path Length")+
+   theme_hc() +
+   theme(axis.text = element_text(face = "bold", size = rel(1.2)),
+         axis.title = element_text(face = "bold", size = rel(1.2)),
+         strip.text.x = element_text(face = "bold", size = rel(1.4)),
+         plot.title = element_text(face = "bold", size = rel(1.2), hjust = .5))
```



## 8.2 RT Figure

```
> net_final_z %>%
+   ggplot(aes(x = zPrimeRecogRT_trim, y = zTargetRecogRT_trim,
+             group = pathlength, color = pathlength)) +
+   geom_smooth(method = "lm", se = FALSE) +
+   xlab("z-RT to Demask Prime") + ylab ("Mean Target Accuracy") +
+   ggtitle("Target Accuracy as a Function of \n RT to Demask Prime & Path Length") +
+   theme_hc() +
+   theme(axis.text = element_text(face = "bold", size = rel(1.2)),
```

```
+ axis.title = element_text(face = "bold", size = rel(1.2)),
+ strip.text.x = element_text(face = "bold", size = rel(1.4)),
+ plot.title = element_text(face = "bold", size = rel(1.2), hjust = .5))
```



## 9 Undirected Network

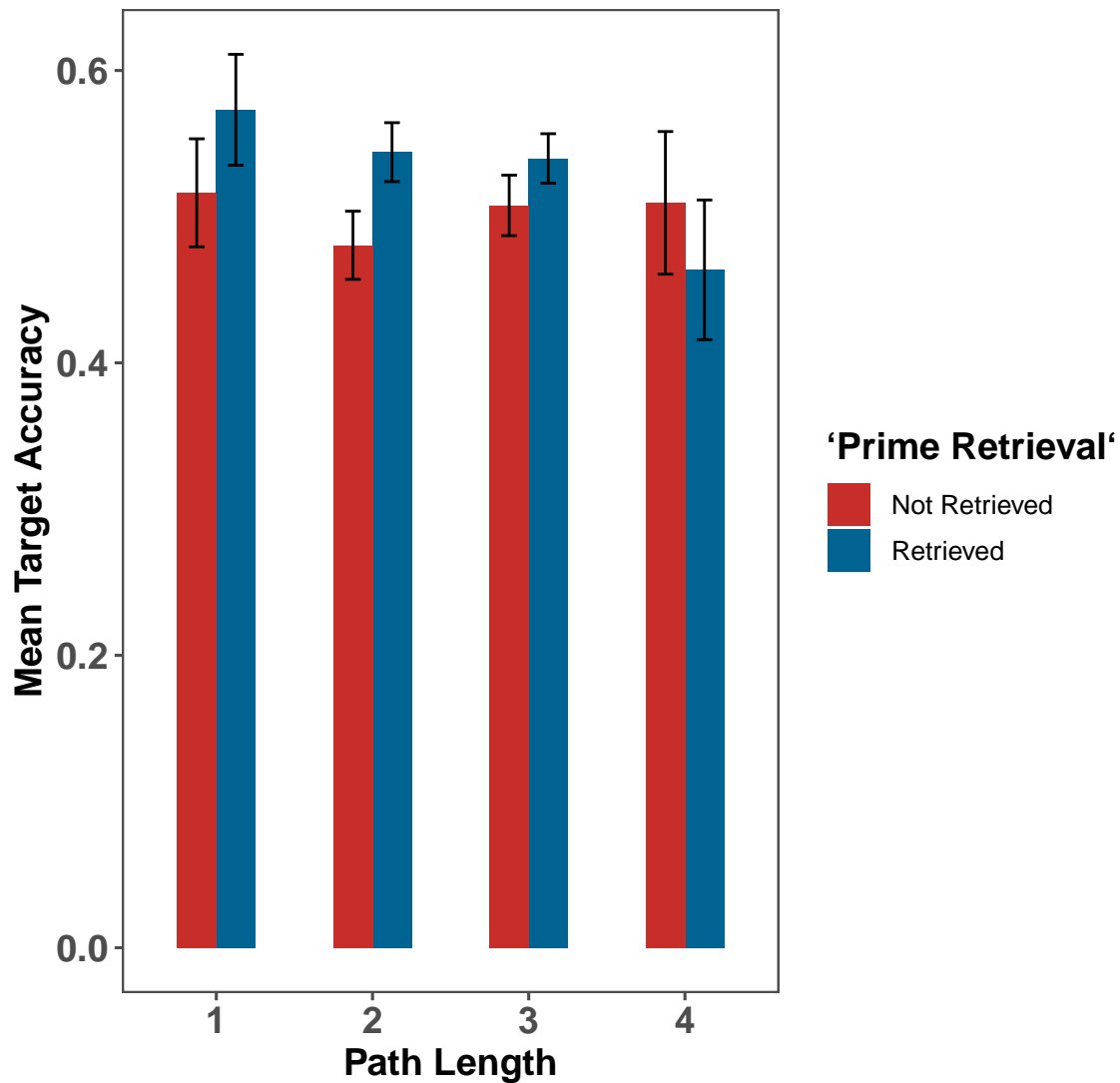
```
> undirected_subject = group_by(net, Subject,
+                               Undirected, PrimeFirstResp_ACC) %>%
+   summarize_at(vars(TargetAccuracy), mean)
> undirected_rmisc = Rmisc::summarySE(net,
```

```

+           measurevar = "TargetAccuracy",
+           groupvars = c("Undirected", "PrimeFirstResp_ACC"))
> undirected_rmisc$PrimeFirstResp_ACC = as.factor(undirected_rmisc$PrimeFirstResp_ACC)
> undirected_rmisc$Undirected = as.factor(undirected_rmisc$Undirected)
> undirected_rmisc = undirected_rmisc %>% filter(!is.na(undirected_rmisc$Undirected))
> library(ggplot2)
> library(ggthemes)
> undirected_rmisc %>% mutate(`Prime Retrieval` = factor(PrimeFirstResp_ACC,
+           levels = unique(PrimeFirstResp_ACC),
+           labels = c("Not Retrieved", "Retrieved")))%>%
+ ggplot(aes(x = Undirected,
+           y = TargetAccuracy,
+           fill = `Prime Retrieval`, group = `Prime Retrieval`))+
+   geom_bar(stat = "identity", position = "dodge",
+           width = 0.5)+
+   geom_errorbar(aes(ymin = TargetAccuracy - se,
+           ymax = TargetAccuracy + se),
+           width=.2, position=position_dodge(.5)) +
+   theme_few()+
+   scale_fill_wsj()+
+   xlab("Path Length") + ylab("Mean Target Accuracy") +
+   ggtitle("Target Accuracy by Path Length & Prime Accuracy") +
+   theme(axis.text = element_text(face = "bold", size = rel(1.2)),
+         axis.title = element_text(face = "bold", size = rel(1.2)),
+         legend.title = element_text(face = "bold", size = rel(1.2)),
+         plot.title = element_text( size = rel(1), hjust = .5))
>

```

Target Accuracy by Path Length & Prime Accuracy



### Undirected Model

```
> retrieval_model_undirected = glmer(data = net,
+                                     TargetAccuracy ~ Undirected*PrimeFirstResp_ACC +
+                                     (1|Subject) + (1|Stimuli1), family = "binomial",
+                                     control = glmerControl(optimizer = "optimx",
+                                                             calc.derivs = FALSE,
+                                                             optCtrl = list(method = "nlsminb", starttests = FALSE, kkt = FALSE)))
> summary(retrieval_model_undirected)
```

```

Generalized linear mixed model fit by maximum likelihood (Laplace
Approximation) [glmerMod]
Family: binomial ( logit )
Formula: TargetAccuracy ~ Undirected * PrimeFirstResp_ACC + (1 | Subject) +
(1 | Stimuli1)
Data: net
Control:
glmerControl(optimizer = "optimx", calc.derivs = FALSE, optCtrl = list(method = "nlnmb",
starttests = FALSE, kkt = FALSE))

      AIC      BIC    logLik deviance df.resid
3441.2    3477.4   -1714.6    3429.2     3089

Scaled residuals:
    Min       1Q   Median       3Q      Max
-4.0550 -0.6528  0.2071  0.6580  3.5492

Random effects:
 Groups      Name      Variance Std.Dev.
Stimuli1 (Intercept) 2.3458    1.5316
Subject   (Intercept) 0.2456    0.4956
Number of obs: 3095, groups: Stimuli1, 72; Subject, 43

Fixed effects:
              Estimate Std. Error z value Pr(>|z|)
(Intercept)      0.33244    0.24998   1.330    0.184
Undirected       -0.07348    0.05949  -1.235    0.217
PrimeFirstResp_ACC1 -0.19938    0.15360  -1.298    0.194
Undirected:PrimeFirstResp_ACC1  0.04700    0.05844   0.804    0.421

Correlation of Fixed Effects:
      (Intr) Undrct PFR_AC
Undirected -0.592
PrmFrR_ACC1 -0.012  0.022
Un:PFR_ACC1  0.009 -0.005 -0.953

```

```
> car::Anova(retrieval_model_undirected)
```

```
Analysis of Deviance Table (Type II Wald chisquare tests)
```

```
Response: TargetAccuracy
```

	Chisq	Df	Pr(>Chisq)
Undirected	1.5167	1	0.21812
PrimeFirstResp_ACC	3.0948	1	0.07854 .
Undirected:PrimeFirstResp_ACC	0.6468	1	0.42125

```
---
```

```
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```
> options(contrasts = c("contr.sum","contr.poly"))
> anova(retrieval_model_undirected)
```

#### Analysis of Variance Table

	Df	Sum Sq	Mean Sq	F value
Undirected	1	1.28272	1.28272	1.2827
PrimeFirstResp_ACC	1	3.09477	3.09477	3.0948
Undirected:PrimeFirstResp_ACC	1	0.64681	0.64681	0.6468

```
> RTprime_acc_model_undirected = glmer(data = net_final_z,
+                                     TargetAccuracy ~ zPrimeRecogRT_trim*Undirected +
+                                     (1|Subject) + (1|Stimuli1), family = binomial )
> summary(RTprime_acc_model_undirected)
```

Generalized linear mixed model fit by maximum likelihood (Laplace Approximation) [glmerMod]  
Family: binomial ( logit )  
Formula: TargetAccuracy ~ zPrimeRecogRT\_trim \* Undirected + (1 | Subject) + (1 | Stimuli1)  
Data: net\_final\_z

AIC	BIC	logLik	deviance	df.resid
3304.3	3340.2	-1646.1	3292.3	2954

#### Scaled residuals:

Min	1Q	Median	3Q	Max
-3.9084	-0.6584	0.2212	0.6547	3.2520

#### Random effects:

Groups	Name	Variance	Std.Dev.
Stimuli1	(Intercept)	2.3626	1.5371
Subject	(Intercept)	0.2567	0.5067

Number of obs: 2960, groups: Stimuli1, 72; Subject, 43

#### Fixed effects:

	Estimate	Std. Error	z value	Pr(> z )
(Intercept)	0.32741	0.25439	1.287	0.198
zPrimeRecogRT_trim	0.05708	0.14657	0.389	0.697
Undirected	-0.05249	0.06147	-0.854	0.393
zPrimeRecogRT_trim:Undirected	-0.02059	0.05623	-0.366	0.714

#### Correlation of Fixed Effects:

	(Intr)	zPrRRT_ Undrct
zPrmRcgRT_t	-0.071	
Undirected	-0.603	0.111
zPrmRcRT_:U	0.068	-0.950

```
> car::Anova(RTprime_acc_model_undirected)
```

```
Analysis of Deviance Table (Type II Wald chisquare tests)
```

```
Response: TargetAccuracy
```

	Chisq	Df	Pr(>Chisq)
zPrimeRecogRT_trim	0.0177	1	0.8942
Undirected	0.8056	1	0.3694
zPrimeRecogRT_trim:Undirected	0.1341	1	0.7142

```
> options(contrasts = c("contr.sum","contr.poly"))
```

```
> anova(RTprime_acc_model_undirected)
```

```
Analysis of Variance Table
```

	Df	Sum Sq	Mean Sq	F value
zPrimeRecogRT_trim	1	0.02659	0.02659	0.0266
Undirected	1	0.81654	0.81654	0.8165
zPrimeRecogRT_trim:Undirected	1	0.13598	0.13598	0.1360

```
> RTprime_RT_model_undirected = lmer(data = net_final_z,
+                                     zTargetRecogRT_trim ~ zPrimeRecogRT_trim*Undirected +
+                                     (1|Subject) + (1|Stimuli1) )
> summary(RTprime_RT_model_undirected)
```

```
Linear mixed model fit by REML. t-tests use Satterthwaite's method [
lmerModLmerTest]
```

```
Formula: zTargetRecogRT_trim ~ zPrimeRecogRT_trim * Undirected + (1 |
Subject) + (1 | Stimuli1)
```

```
Data: net_final_z
```

```
REML criterion at convergence: 7950.2
```

```
Scaled residuals:
```

Min	1Q	Median	3Q	Max
-2.7053	-0.6309	-0.2374	0.4296	4.7117

```
Random effects:
```

Groups	Name	Variance	Std.Dev.
Stimuli1	(Intercept)	0.1703	0.4127
Subject	(Intercept)	0.0000	0.0000
Residual		0.8079	0.8989

```
Number of obs: 2960, groups: Stimuli1, 72; Subject, 43
```

```
Fixed effects:
```

	Estimate	Std. Error	df	t value	Pr(> t )
(Intercept)	-4.110e-03	7.630e-02	3.156e+02	-0.054	0.9571
zPrimeRecogRT_trim	1.037e-01	5.378e-02	2.910e+03	1.929	0.0539



```

Undirected          1.558e-03  2.263e-02  2.950e+03  0.069  0.9451
zPrimeRecogRT_trim:Undirected  1.083e-02  2.074e-02  2.909e+03  0.522  0.6017

(Intercept)
zPrimeRecogRT_trim      .
Undirected
zPrimeRecogRT_trim:Undirected
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Correlation of Fixed Effects:
      (Intr) zPrRRT_ Undrct
zPrmRcgRT_t  -0.080
Undirected   -0.739  0.099
zPrmRcRT_:U   0.073 -0.948 -0.089

```

```
> car::Anova(RTprime_RT_model_undirected)
```

```
Analysis of Deviance Table (Type II Wald chisquare tests)
```

```

Response: zTargetRecogRT_trim

              Chisq Df Pr(>Chisq)
zPrimeRecogRT_trim      57.5359  1  3.319e-14 ***
Undirected              0.0134  1    0.9080
zPrimeRecogRT_trim:Undirected  0.2725  1    0.6016
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

```

```

> options(contrasts = c("contr.sum","contr.poly"))
> anova(RTprime_RT_model_undirected)

```

```

Type III Analysis of Variance Table with Satterthwaite's method

              Sum Sq Mean Sq NumDF  DenDF F value  Pr(>F)
zPrimeRecogRT_trim      3.00538  3.00538      1 2909.7   3.7198 0.05387 .
Undirected              0.00383  0.00383      1 2950.1   0.0047 0.94514
zPrimeRecogRT_trim:Undirected  0.22018  0.22018      1 2908.7   0.2725 0.60169
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

```

## 10 Directed Network

```

> net$newdirected = ifelse(net$Directed == "Inf" |
+                          net$Directed == "NA", NA,
+                          net$Directed)
> directed_rmisc = Rmisc::summarySE(net,
+                                   measurevar = "TargetAccuracy",

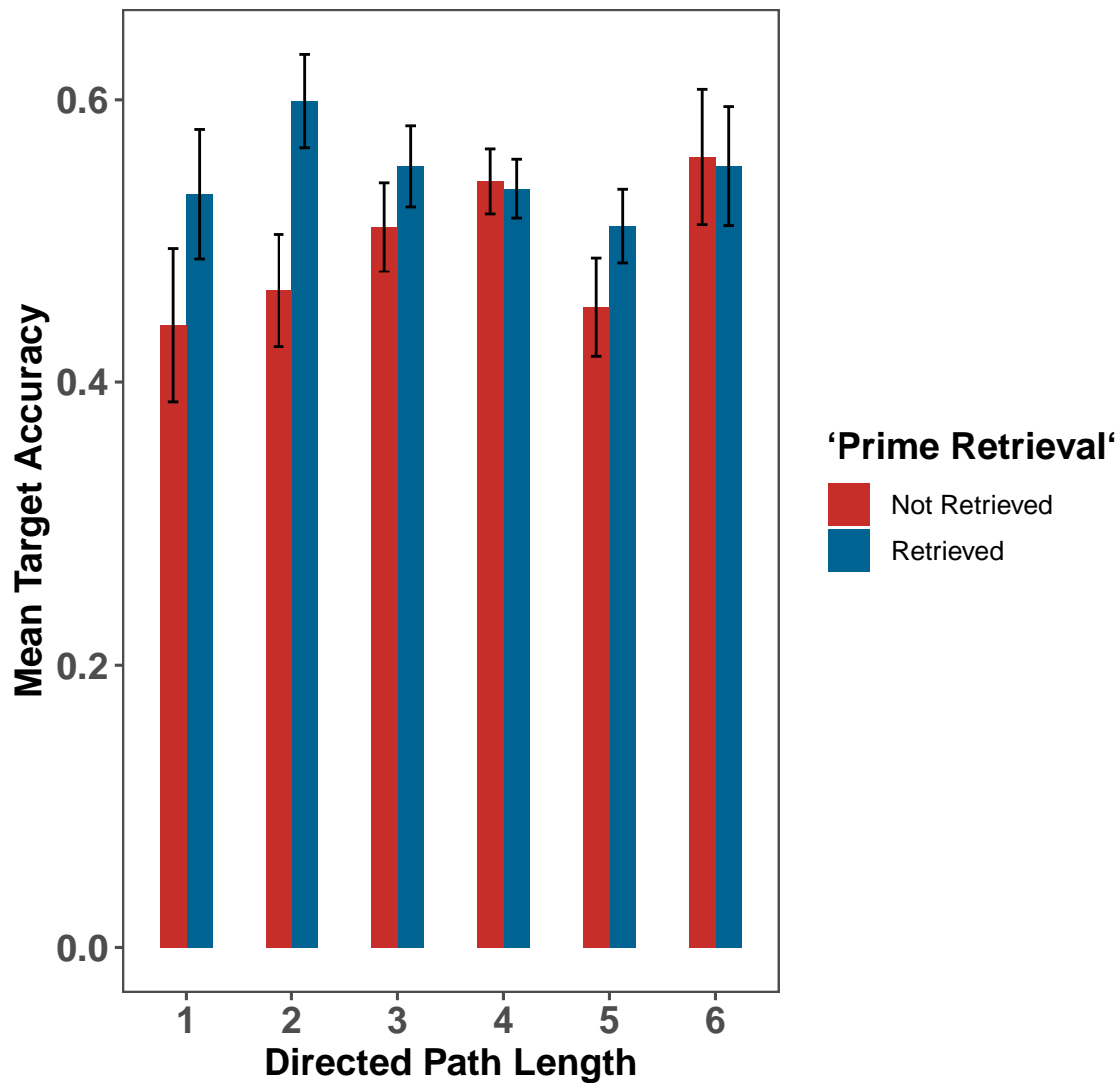
```

```

+           groupvars = c("newdirected", "PrimeFirstResp_ACC"))
> directed_rmisc = directed_rmisc %>% filter(!is.na(newdirected))
> directed_rmisc$PrimeFirstResp_ACC = as.factor(directed_rmisc$PrimeFirstResp_ACC)
> directed_rmisc$newdirected = as.factor(directed_rmisc$newdirected)
> library(ggplot2)
> library(ggthemes)
> directed_rmisc %>% mutate(`Prime Retrieval` = factor(PrimeFirstResp_ACC,
+           levels = unique(PrimeFirstResp_ACC),
+           labels = c("Not Retrieved", "Retrieved")))%>%
+ ggplot(aes(x = newdirected,
+           y = TargetAccuracy,
+           fill = `Prime Retrieval`, group = `Prime Retrieval`))+
+   geom_bar(stat = "identity", position = "dodge",
+           width = 0.5)+
+   geom_errorbar(aes(ymin = TargetAccuracy - se,
+           ymax = TargetAccuracy + se),
+           width=.2, position=position_dodge(.5)) +
+   theme_few()+
+   scale_fill_wsj()+
+   xlab("Directed Path Length") + ylab("Mean Target Accuracy") +
+   ggtitle("Target Accuracy by Path Length & Prime Accuracy") +
+   theme(axis.text = element_text(face = "bold", size = rel(1.2)),
+         axis.title = element_text(face = "bold", size = rel(1.2)),
+         legend.title = element_text(face = "bold", size = rel(1.2)),
+         plot.title = element_text( size = rel(1), hjust = .5))
>

```

Target Accuracy by Path Length & Prime Accuracy



## Directed Model

```
> retrieval_model_directed = glmer(data = net,
+   TargetAccuracy ~ newdirected*PrimeFirstResp_ACC +
+   (1|Subject) + (1|Stimuli1), family = "binomial",
+   control = glmerControl(optimizer = "optimx",
+   calc.derivs = FALSE,
+   optCtrl = list(method = "nlsminb", starttests = FALSE, kkt = FALSE)))
> summary(retrieval_model_directed)
```

```

Generalized linear mixed model fit by maximum likelihood (Laplace
Approximation) [glmerMod]
Family: binomial ( logit )
Formula: TargetAccuracy ~ newdirected * PrimeFirstResp_ACC + (1 | Subject) +
(1 | Stimuli1)
Data: net
Control:
glmerControl(optimizer = "optimx", calc.derivs = FALSE, optCtrl = list(method = "nlminb",
starttests = FALSE, kkt = FALSE))

          AIC          BIC    logLik deviance df.resid
3331.3      3367.4    -1659.6   3319.3      3004

Scaled residuals:
    Min       1Q   Median       3Q      Max
-4.1779 -0.6434  0.2162  0.6436  3.4527

Random effects:
 Groups      Name      Variance Std.Dev.
Stimuli1 (Intercept) 2.4100    1.5524
Subject (Intercept) 0.2498    0.4998
Number of obs: 3010, groups: Stimuli1, 72; Subject, 43

Fixed effects:
              Estimate Std. Error z value Pr(>|z|)
(Intercept)      0.49414    0.25233   1.958   0.0502 .
newdirected     -0.08919    0.03997  -2.232   0.0256 *
PrimeFirstResp_ACC1 -0.39331    0.14228  -2.764   0.0057 **
newdirected:PrimeFirstResp_ACC1 0.08337    0.03576   2.332   0.0197 *
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Correlation of Fixed Effects:
              (Intr) nwdrct PFR_AC
newdirected -0.588
PrmFrR_ACC1 0.074 -0.115
nw:PFR_ACC1 -0.069 0.122 -0.943

```

```
> car::Anova(retrieval_model_directed)
```

```
Analysis of Deviance Table (Type II Wald chisquare tests)
```

```
Response: TargetAccuracy
```

	Chisq	Df	Pr(>Chisq)
newdirected	6.4287	1	0.01123 *
PrimeFirstResp_ACC	2.8923	1	0.08901 .
newdirected:PrimeFirstResp_ACC	5.4363	1	0.01972 *

```
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```
> options(contrasts = c("contr.sum", "contr.poly"))
> anova(retrieval_model_directed)
```

#### Analysis of Variance Table

	Df	Sum Sq	Mean Sq	F value
newdirected	1	6.4251	6.4251	6.4251
PrimeFirstResp_ACC	1	2.8923	2.8923	2.8923
newdirected:PrimeFirstResp_ACC	1	5.4363	5.4363	5.4363

```
> net_final_z$newdirected = ifelse(net_final_z$Directed == "Inf" |
+                               net_final_z$Directed == "NA", NA,
+                               net_final_z$Directed)
> RTprime_acc_model_directed = glmer(data = net_final_z,
+                               TargetAccuracy ~ zPrimeRecogRT_trim*newdirected +
+                               (1|Subject) + (1|Stimuli1), family = binomial )
> summary(RTprime_acc_model_directed)
```

#### Generalized linear mixed model fit by maximum likelihood (Laplace Approximation) [glmerMod]

```
Family: binomial ( logit )
Formula: TargetAccuracy ~ zPrimeRecogRT_trim * newdirected + (1 | Subject) +
(1 | Stimuli1)
Data: net_final_z
```

AIC	BIC	logLik	deviance	df.resid
3207.9	3243.7	-1597.9	3195.9	2878

#### Scaled residuals:

Min	1Q	Median	3Q	Max
-4.0214	-0.6534	0.2243	0.6429	3.2936

#### Random effects:

Groups	Name	Variance	Std.Dev.
Stimuli1	(Intercept)	2.4120	1.553
Subject	(Intercept)	0.2652	0.515

Number of obs: 2884, groups: Stimuli1, 72; Subject, 43

#### Fixed effects:

	Estimate	Std. Error	z value	Pr(> z )
(Intercept)	0.54810	0.25496	2.150	0.0316 *
zPrimeRecogRT_trim	0.05632	0.14051	0.401	0.6885
newdirected	-0.09142	0.04073	-2.244	0.0248 *
zPrimeRecogRT_trim:newdirected	-0.01339	0.03581	-0.374	0.7083

```
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```
Correlation of Fixed Effects:
              (Intr) zPrRRT_ nwdrct
zPrmRcgRT_t   -0.011
newdirected   -0.593   0.019
zPrmRcgRT_:   0.015  -0.942  -0.024
```

```
> car::Anova(RTprime_acc_model_directed)
```

```
Analysis of Deviance Table (Type II Wald chisquare tests)
```

```
Response: TargetAccuracy
```

	Chisq	Df	Pr(>Chisq)
zPrimeRecogRT_trim	0.0208	1	0.88523
newdirected	5.0818	1	0.02418 *
zPrimeRecogRT_trim:newdirected	0.1399	1	0.70834

```
---
```

```
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```
> options(contrasts = c("contr.sum","contr.poly"))
> anova(RTprime_acc_model_directed)
```

```
Analysis of Variance Table
```

	Df	Sum Sq	Mean Sq	F value
zPrimeRecogRT_trim	1	0.0127	0.0127	0.0127
newdirected	1	5.1439	5.1439	5.1439
zPrimeRecogRT_trim:newdirected	1	0.1412	0.1412	0.1412

```
> RTprime_RT_model_directed = lmer(data = net_final_z,
+                                zTargetRecogRT_trim ~ zPrimeRecogRT_trim*newdirected +
+                                (1|Subject) + (1|Stimuli1) )
> summary(RTprime_RT_model_directed)
```

```
Linear mixed model fit by REML. t-tests use Satterthwaite's method [
lmerModLmerTest]
Formula: zTargetRecogRT_trim ~ zPrimeRecogRT_trim * newdirected + (1 |
  Subject) + (1 | Stimuli1)
Data: net_final_z
```

```
REML criterion at convergence: 7761.5
```

```
Scaled residuals:
```

Min	1Q	Median	3Q	Max
-2.5878	-0.6236	-0.2395	0.4315	4.7258

```
Random effects:
```

Groups	Name	Variance	Std.Dev.
--------	------	----------	----------

```

Stimuli1 (Intercept) 1.779e-01 4.218e-01
Subject (Intercept) 5.566e-52 2.359e-26
Residual 8.103e-01 9.002e-01
Number of obs: 2884, groups: Stimuli1, 72; Subject, 43

Fixed effects:
              Estimate Std. Error      df t value
(Intercept) -5.210e-02 7.519e-02 2.669e+02 -0.693
zPrimeRecogRT_trim 1.308e-01 5.057e-02 2.843e+03 2.587
newdirected 1.537e-02 1.452e-02 2.870e+03 1.059
zPrimeRecogRT_trim:newdirected 9.929e-04 1.290e-02 2.841e+03 0.077
Pr(>|t|)
(Intercept) 0.48893
zPrimeRecogRT_trim 0.00972 **
newdirected 0.28969
zPrimeRecogRT_trim:newdirected 0.93864
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Correlation of Fixed Effects:
      (Intr) zPrRRT_ nwdrct
zPrmRcgRT_t -0.007
newdirected -0.716 0.010
zPrmRcgRT_: 0.009 -0.937 -0.009

```

```
> car::Anova(RTprime_RT_model_directed)
```

```
Analysis of Deviance Table (Type II Wald chisquare tests)
```

```

Response: zTargetRecogRT_trim
              Chisq Df Pr(>Chisq)
zPrimeRecogRT_trim 58.2193 1 2.345e-14 ***
newdirected 1.1231 1 0.2893
zPrimeRecogRT_trim:newdirected 0.0059 1 0.9386
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

```

```
> options(contrasts = c("contr.sum","contr.poly"))
> anova(RTprime_RT_model)
```

```

Type III Analysis of Variance Table with Satterthwaite's method
              Sum Sq Mean Sq NumDF DenDF F value Pr(>F)
zPrimeRecogRT_trim 47.946 47.946 1 2914.4 59.4344 1.722e-14 ***
pathlength 3.425 1.142 3 2883.9 1.4151 0.2364
zPrimeRecogRT_trim:pathlength 2.457 0.819 3 2912.1 1.0152 0.3848
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

```