

Models and Results of the Statistical Analysis (Linear Mixed Effect Models) of Online Processing English Past Tense and Progressive Aspect

1. Overall

```
model.11 <- lmer(log(V1) ~ TA*GROUP*TYPE + (1|SUBJ) + (1|ITEM),data= x_01, REML =
FALSE)

summary(model.11)

library(lsmmeans)

library(emmeans)

lsmmeans(model.11,pairwise ~ GROUP * TYPE * TA, adjust = "tukey")

emms1 <- emmeans(model.11,~ GROUP*TYPE*TA)

contrast(emms1,interaction = "pairwise")

afex::mixed(log(V1) ~ GROUP*TYPE*TA + (1|ITEM) + (1|SUBJ),data =x_01,
            method = "LRT")
```

Effects	df	Chisq	p.value
GROUP	2	169.64 ***	<.001
TYPE	2	128.21 ***	<.001
TA	1	1.96	.162
GROUP:TYPE	4	7.02	.135
GROUP:TA	2	21.93 ***	<.001
TYPE:TA	2	77.92 ***	<.001
GROUP:TYPE:TA	4	67.53 ***	<.001

Fixed effects:

	Estimate	Std. Error	t value
(Intercept)	6.931748	0.018165	381.607
TAPRO	-0.153595	0.024472	-6.276
GROUPCH_L	0.072761	0.023270	3.127
GROUPNS	-0.184115	0.023292	-7.905
TYPEp	-0.178376	0.024450	-7.295
TYPEs	0.098420	0.024650	3.993
TAPRO:GROUPCH_L	-0.071755	0.032972	-2.176
TAPRO:GROUPNS	0.174010	0.033049	5.265
TAPRO:TYPEp	0.250955	0.034638	7.245
TAPRO:TYPEs	0.135861	0.034950	3.887
GROUPCH_L:TYPEp	-0.081567	0.033066	-2.467
GROUPNS:TYPEp	0.134953	0.033034	4.085
GROUPCH_L:TYPEs	0.001052	0.033382	0.032
GROUPNS:TYPEs	0.084455	0.033150	2.548
TAPRO:GROUPCH_L:TYPEp	0.225314	0.046751	4.819
TAPRO:GROUPNS:TYPEp	-0.153951	0.046749	-3.293
TAPRO:GROUPCH_L:TYPEs	0.063741	0.047193	1.351
TAPRO:GROUPNS:TYPEs	-0.107112	0.046971	-2.280

2. Past tense

```
model.11 <- lmer(log(V1) ~ GROUP*TYPE + (1|SUBJ) + (1|ITEM),data= x_01, REML = FALSE)
```

```
summary(model.11)
```

```
library(lsmmeans)
```

```
library(emmeans)
```

```
lsmmeans(model.11,pairwise ~ GROUP * TYPE, adjust = "tukey")
```

```
emms1 <- emmeans(model.11,~ GROUP|TYPE)
```

```
contrast(emms1,interaction = "pairwise")
```

```
afex::mixed(log(V1) ~ GROUP*TYPE + (1|ITEM) + (1|SUBJ),data =x_01,  
             method = "LRT")
```

regions	Effects	df	Chisq	p.value
V	GROUP	2	151.57 ***	<.001
	TYPE	2	76.08 ***	<.001
	GROUP:TYPE	4	47.76 ***	<.001
V+1	GROUP	2	151.89 ***	<.001
	TYPE	2	443.89 ***	<.001
	GROUP:TYPE	4	47.08 ***	<.001
V+2	GROUP	2	153.86 ***	<.001
	TYPE	2	535.37 ***	<.001
	GROUP:TYPE	4	62.86 ***	<.001
SF	GROUP	2	162.14 ***	<.001
	TYPE	2	508.44 ***	<.001
	GROUP:TYPE	4	67.37 ***	<.001

Results At the critical region

```
Fixed effects:
              Estimate Std. Error t value
(Intercept)    6.931894   0.018025  384.562
GROUPCH_L      0.072501   0.022285   3.253
GROUPNS       -0.184037   0.022305  -8.251
TYPEp         -0.178577   0.023835  -7.492
TYPES          0.098012   0.024024   4.080
GROUPCH_L:TYPEp -0.080888   0.031666  -2.554
GROUPNS:TYPEp   0.132085   0.031650   4.173
GROUPCH_L:TYPEs  0.002034   0.031971   0.064
GROUPNS:TYPEs   0.084733   0.031746   2.669

Correlation of Fixed Effects:
              (Intr) GROUPCH_L GROUPNS TYPEp  TYPES  GROUPCH_L:TYPEp GROUPNS:TYPEp
GROUPCH_L    -0.617
GROUPNS      -0.616  0.499
TYPEp        -0.657  0.467   0.466
TYPES        -0.652  0.463   0.462  0.493
GROUPCH_L:TYPEp  0.434 -0.704  -0.351 -0.662 -0.326
GROUPNS:TYPEp   0.434 -0.351  -0.705 -0.662 -0.326  0.498
GROUPCH_L:TYPEs  0.430 -0.697  -0.348 -0.325 -0.662  0.491   0.245
GROUPNS:TYPEs   0.433 -0.350  -0.703 -0.327 -0.667  0.246   0.495
              GROUPCH_L:TYPEs
GROUPCH_L
GROUPNS
TYPEp
TYPES
GROUPCH_L:TYPEp
GROUPNS:TYPEp
GROUPCH_L:TYPEs
GROUPNS:TYPEs   0.501
> |
```

3. Progressive

```
model.11 <- lmer(log(V1) ~ GROUP*TYPE + (1|ITEM) + (1|SUBJ),data= x_01, REML = FALSE)
```

```
summary(model.11)
```

```
library(lsmmeans)
```

```
lsmmeans(model.11,pairwise ~ GROUP * TYPE, adjust = "tukey")
```

```
library(emmeans)
```

```
library(lsmmeans)
```

```
emms1 <- emmeans(model.11,~ GROUP|TYPE)
```

```
contrast(emms1,interaction = "pairwise")
```

```
afex::mixed(log(V1) ~ GROUP*TYPE + (1|ITEM) + (1|SUBJ),data =x_01,
             method = "LRT")
```

regions	Effects	df	Chisq	p.value
V	GROUP	2	49.16 ***	<.001
	TYPE	2	69.78 ***	<.001
	GROUP:TYPE	4	27.39 ***	<.001
V+1	GROUP	2	49.21 ***	<.001
	TYPE	2	303.83 ***	<.001
	GROUP:TYPE	4	27.42 ***	<.001
V+2	GROUP	2	47.33 ***	<.001
	TYPE	2	304.42 ***	<.001
	GROUP:TYPE	4	22.97 ***	<.001
SF	GROUP	2	47.01 ***	<.001
	TYPE	2	302.27 ***	<.001
	GROUP:TYPE	4	22.62 ***	<.001

Results At the critical region

Fixed effects:

	Estimate	Std. Error	t value
(Intercept)	6.777995	0.018928	358.097
GROUPCH-L	0.001145	0.024231	0.047
GROUPNS	-0.009918	0.024323	-0.408
TYPEp	0.075082	0.024825	3.024
TYPEs	0.237754	0.025055	9.489
GROUPCH-L:TYPEp	0.142861	0.034251	4.171
GROUPNS:TYPEp	-0.021617	0.034299	-0.630
GROUPCH-L:TYPEs	0.062914	0.034551	1.821
GROUPNS:TYPEs	-0.025918	0.034484	-0.752

Correlation of Fixed Effects:

	(Intr)	GROUPCH-L	GROUPNS	TYPEp	TYPEs	GROUPCH-L:TYPEp	GROUPNS:TYPEp
GROUPCH-L	-0.646						
GROUPNS	-0.644	0.503					
TYPEp	-0.659	0.493	0.491				
TYPEs	-0.653	0.488	0.486	0.498			
GROUPCH-L:TYPEp	0.457	-0.707	-0.356	-0.693	-0.345		
GROUPNS:TYPEp	0.456	-0.357	-0.709	-0.692	-0.345	0.502	
GROUPCH-L:TYPEs	0.453	-0.701	-0.353	-0.345	-0.694	0.496	0.250
GROUPNS:TYPEs	0.454	-0.355	-0.705	-0.346	-0.695	0.251	0.500
GROUPCH-L:TYPEs							
GROUPCH-L							
GROUPNS							
TYPEp							
TYPEs							
GROUPCH-L:TYPEp							
GROUPNS:TYPEp							
GROUPCH-L:TYPEs							
GROUPNS:TYPEs	0.504						

```
> contrast(emms1,interaction = "pairwise")
```

TYPE = a:

GROUP_pairwise	estimate	SE	df	t.ratio	p.value
(CH-H) - (CH-L)	-0.00115	0.0243	2324	-0.047	0.9623
(CH-H) - NS	0.00992	0.0244	2325	0.407	0.6839
(CH-L) - NS	0.01106	0.0242	2325	0.456	0.6481

TYPE = p:

GROUP_pairwise	estimate	SE	df	t.ratio	p.value
(CH-H) - (CH-L)	-0.14401	0.0242	2324	-5.941	<.0001
(CH-H) - NS	0.03154	0.0242	2324	1.302	0.1929
(CH-L) - NS	0.17554	0.0242	2325	7.249	<.0001

TYPE = s:

GROUP_pairwise	estimate	SE	df	t.ratio	p.value
(CH-H) - (CH-L)	-0.06406	0.0247	2325	-2.598	0.0094
(CH-H) - NS	0.03584	0.0245	2325	1.464	0.1433
(CH-L) - NS	0.09990	0.0244	2325	4.090	<.0001