

Morphosyntactic Predictability

Last update: 2017-05-08 01:39:53

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1 Study 1: beg, adv, nat

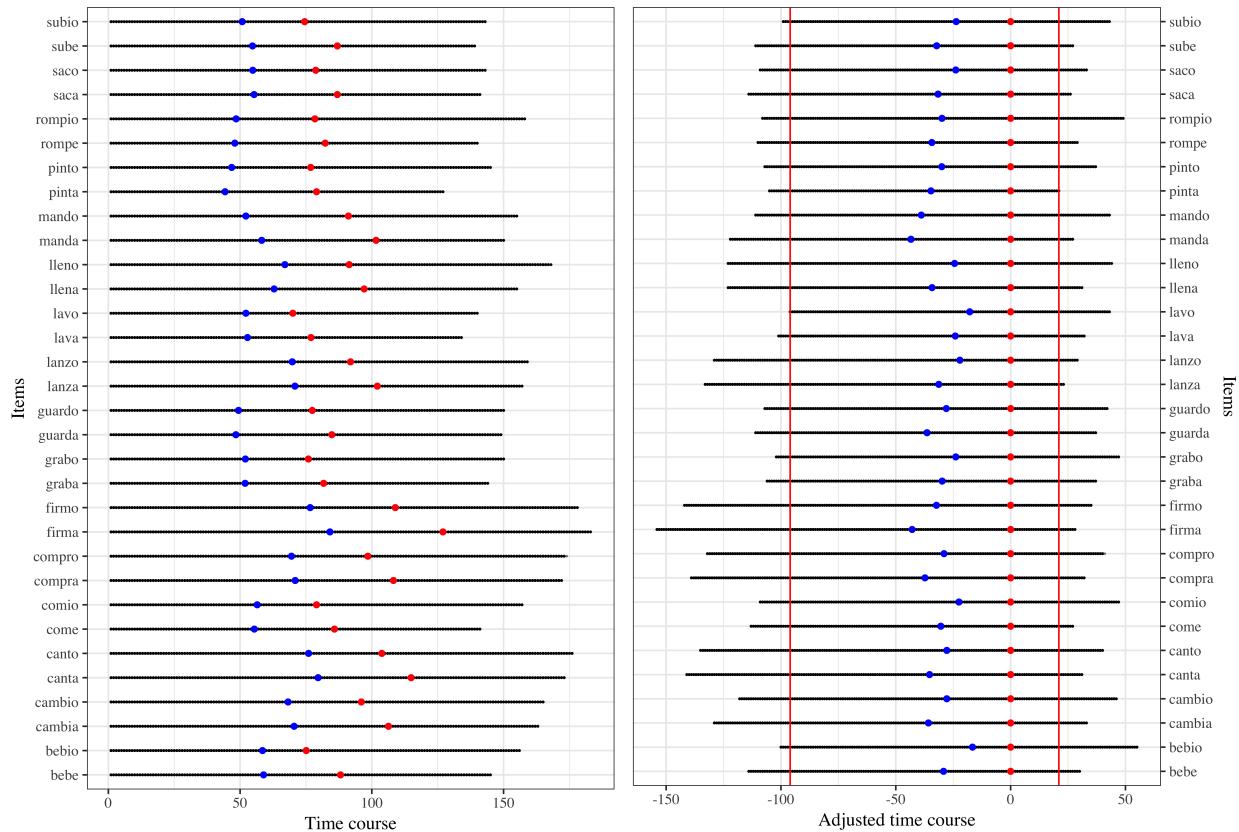
1.1 Stress

1.1.1 Gating

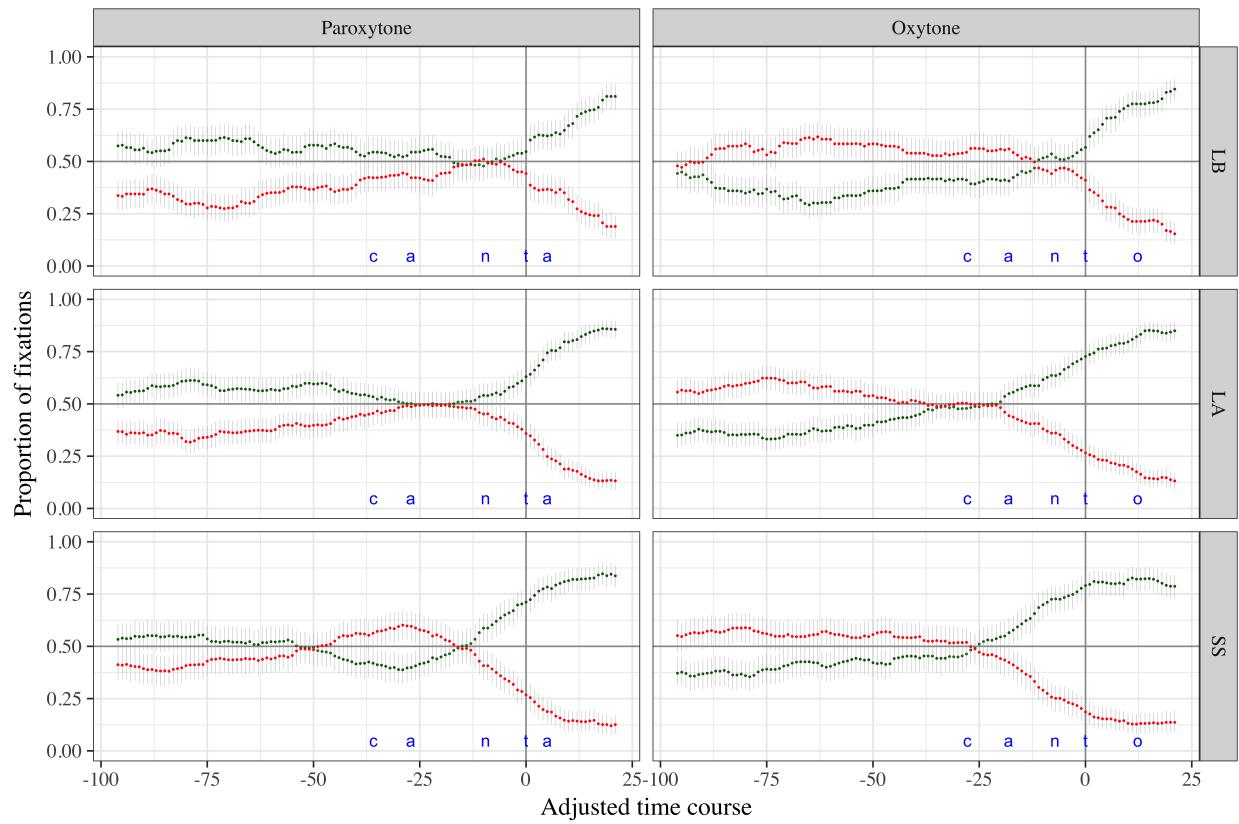
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1.1.2 Eye tracking

1.1.2.1 Bin adjustments and centering Because all the .wav files have different durations we have to normalize the time course. We do this by centering the bins around the onset of the second syllable of the target word. The plot on the left represents the data before normalizing and the plot on the right is the outcome. The blue dots represent the onset of the target word. The red dots represent the onset of the target syllable. The vertical red lines represent the latest onset of the adjusted start point and the earliest end of the target word. Everything between the red lines represents the target window of interest.



1.1.2.2 Time course plot Proportion of fixations to targets and distractors as a function of group (LB, LA, SS) and word type (paroxytone, oxytone).



1.1.2.3 Analyses

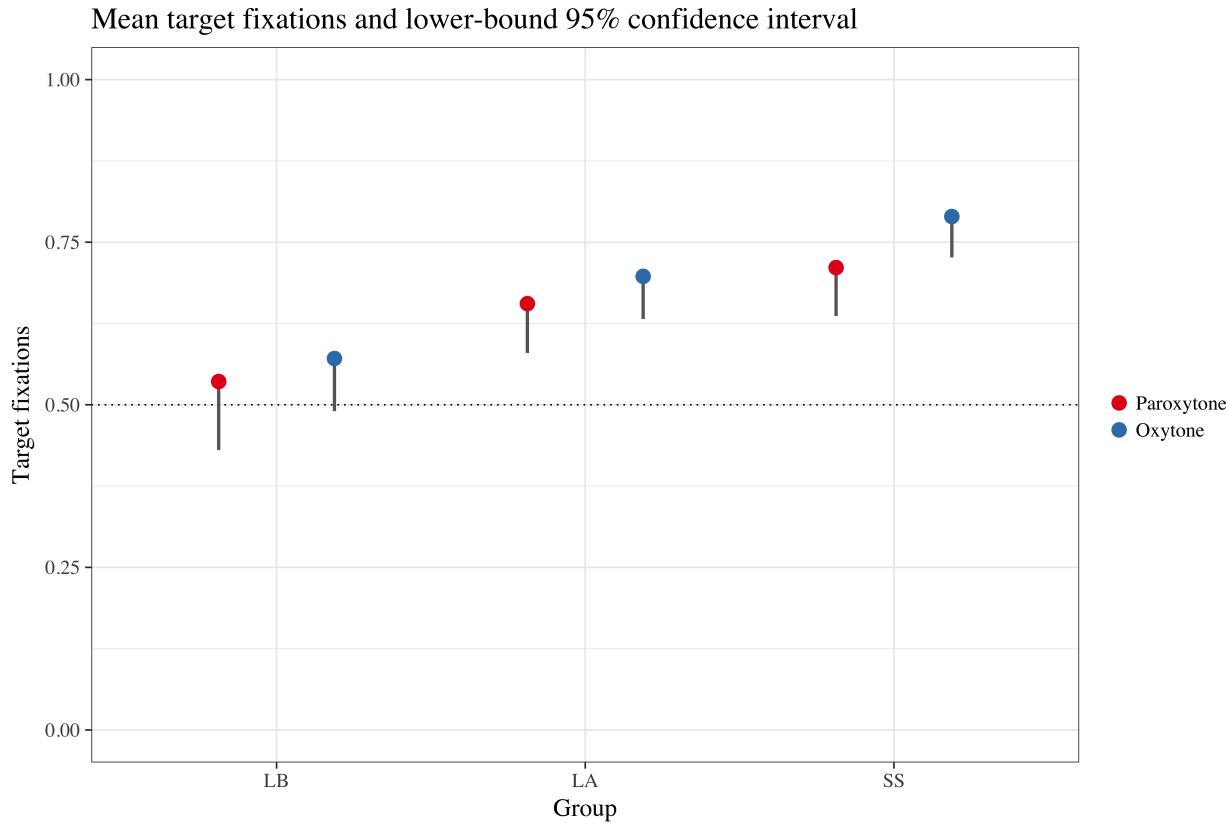
1.1.2.3.1 Is stress used to predict morphology? We want to analyze the proportion of target fixations at the target syllable onset, so we need to make a subset of the data that only uses the target onset bin (binAdj = 0).

We will test this for each group in each condition (stressed, unstressed) using a one-sided t-test. Specifically, we are testing the hypothesis that the proportion of looks is greater than chance (50%).

- H₀: $u = 0.50$
- H_a: $u > 0.50$

The generic code is: `t.test(myVector, alternative = "greater", my = 0.5, conf.level = 0.95)`

Group	Condition	Estimate	statistic	conf.low	df	p.value	sig
lb	stressed	0.54	0.61	0.43	11	0.276	N.S.
lb	unstressed	0.57	1.58	0.49	11	0.071	N.S.
la	stressed	0.66	3.50	0.57	25	0.000	*
la	unstressed	0.69	5.15	0.63	25	0.000	*
ss	stressed	0.71	4.85	0.63	22	0.000	*
ss	unstressed	0.79	7.90	0.72	22	0.000	*



1.1.2.3.2 Do target fixations vary as a function of group and stress at the onset of the target syllable? We use a LMEM to analyze mean target fixations as a function of group, condition and working memory. Main effects and interactions are tested using nested model comparisons.

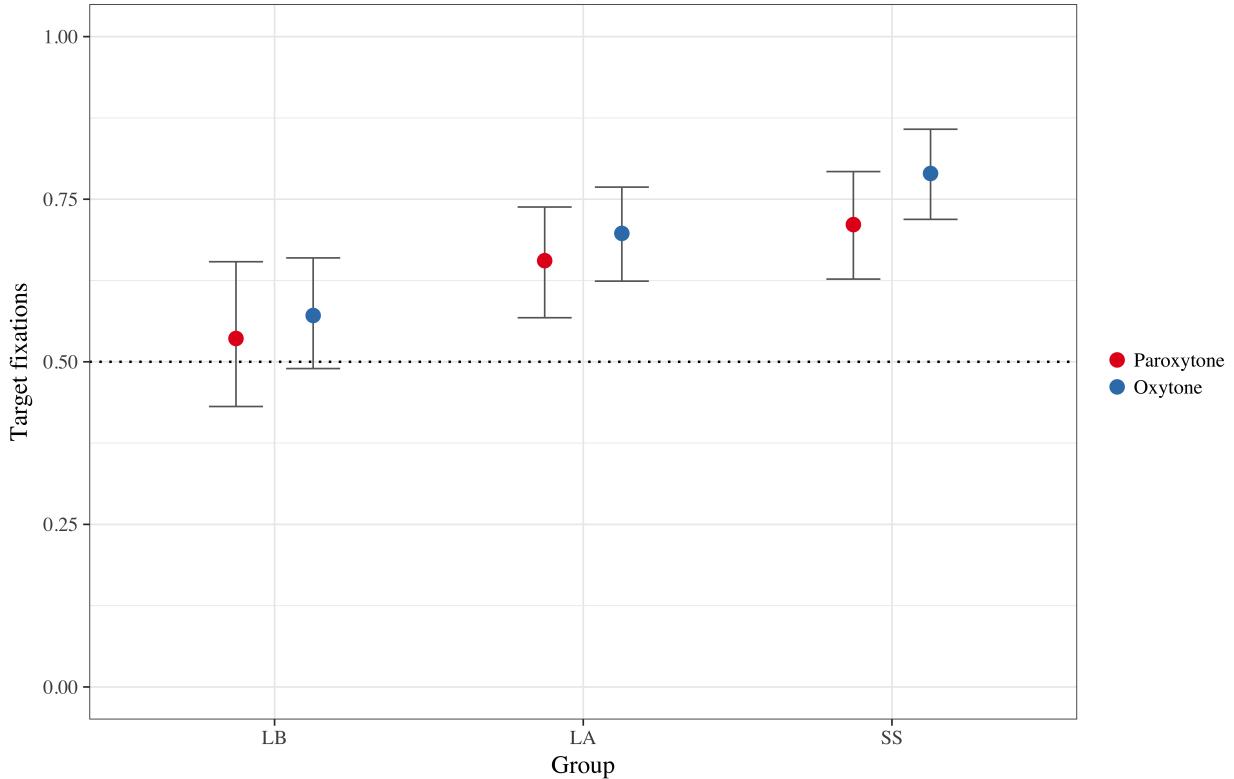
Model	Df	AIC	BIC	logLik	deviance	Chisq	Chi Df	Pr(>Chisq)
Base	3	-30.30	-21.88	18.15	-36.30			
Group	5	-41.24	-27.22	25.62	-51.24	14.94	2	0.0005683 ***
Condition	6	-41.62	-24.79	26.81	-53.62	2.37	1	0.1233552
Group x cond.	8	-37.91	-15.47	26.95	-53.91	0.28	2	0.8651943
WM	9	-36.48	-11.24	27.24	-54.48	0.57	1	0.4489036
Group x cond. x WM	14	-34.89	4.35	31.44	-62.89	8.41	5	0.1349345

There is only a main effect of group. We refit the model to get parameter estimates.

	Estimate	Std. Error	df	t value	Pr(>t)
(Intercept)	0.75	0.028	122.00	25.94	< 2e-16 ***
groupla	-0.07	0.039	122.00	-1.85	0.065569 .
grouplb	-0.19	0.049	122.00	-3.98	0.000116 ***

We can now plot the model with upper and lower bound CI.

Mean target fixations as a function of group and target type



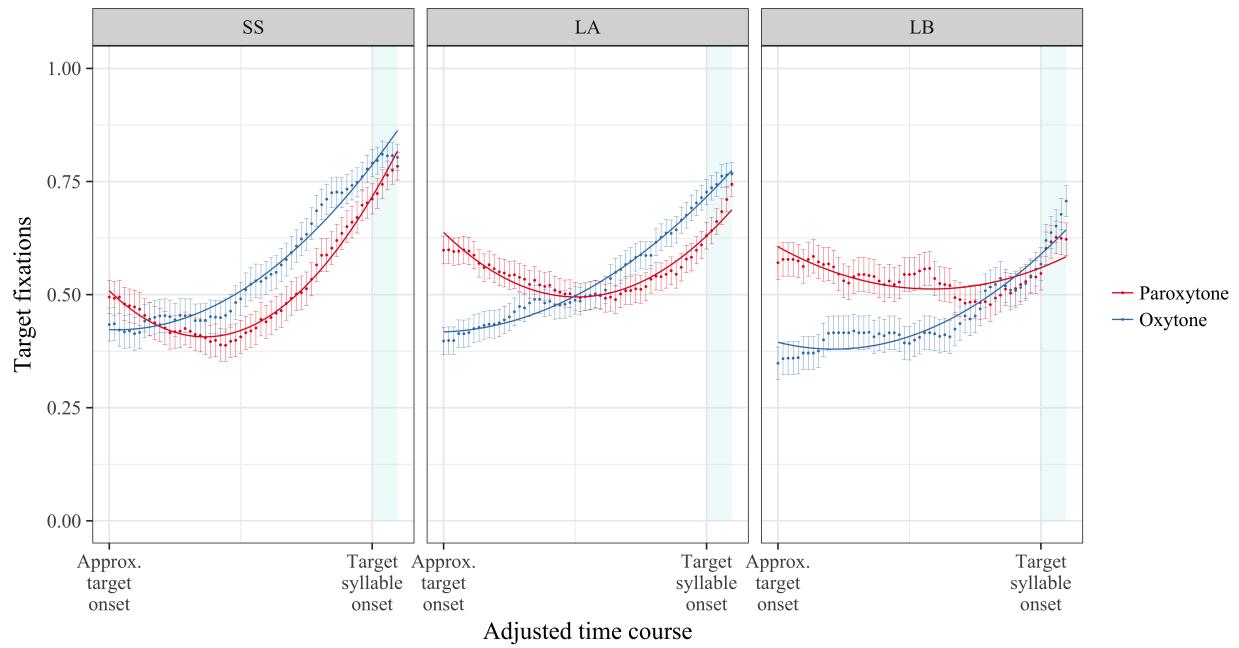
1.1.2.3.3 Do target fixations vary as a function of group and stress over the time course? Check main effects and interaction using nested model comparisons. This includes effects of higher order orthogonal polynomials (intercept, linear slope, and quadratic terms).

	Df	AIC	BIC	logLik	deviance	Chisq	Chi Df	Pr(>Chisq)
Base model	16	97453	97601	-48711	97421			
Group effect on intercept	18	97453	97618	-48708	97417	4.60	2	0.100095
Group effect on slope	20	97445	97628	-48702	97405	12.30	2	0.002124 **
Group effect on quadratic poly	22	97445	97647	-48700	97401	3.77	2	0.151399
Cond effect on intercept	23	97445	97656	-48699	97399	2.04	1	0.153205
Cond effect on slope	24	97431	97652	-48692	97383	15.28	1	9.255e-05 ***
Cond effect on quadratic poly	25	97430	97660	-48690	97380	3.35	1	0.067017 .
Full model	31	97120	97405	-48529	97058	321.72	6	< 2.2e-16 ***

We retain the full model and check parameters.

	Estimate	Std. Error	df	t value	Pr(>t)
(Intercept)	5.118e-01	2.436e-02	8.900e+01	21.009	< 2e-16 ***
ot1	6.938e-01	1.183e-01	8.600e+01	5.863	8.12e-08 ***
ot2	5.388e-01	8.124e-02	9.200e+01	6.632	2.22e-09 ***
groupla	3.404e-02	2.532e-02	6.500e+01	1.344	0.18355
grouplb	2.456e-02	3.129e-02	6.300e+01	0.785	0.43543
conditionunstressed	5.412e-02	2.335e-02	3.500e+01	2.318	0.02641 *
ot1:groupla	-5.446e-01	1.201e-01	6.900e+01	-4.535	2.37e-05 ***
ot1:grouplb	-7.034e-01	1.467e-01	6.400e+01	-4.794	1.01e-05 ***
ot2:groupla	-1.173e-01	8.461e-02	8.300e+01	-1.387	0.16927
ot2:grouplb	-3.481e-01	1.015e-01	7.200e+01	-3.430	0.00101 **
ot1:conditionunstressed	2.866e-01	1.223e-01	4.000e+01	2.344	0.02411 *
ot2:conditionunstressed	-2.692e-01	8.849e-02	5.200e+01	-3.043	0.00368 **
groupla:conditionunstressed	-6.961e-02	8.374e-03	7.252e+04	-8.313	< 2e-16 ***
grouplb:conditionunstressed	-1.483e-01	9.160e-03	7.252e+04	-16.186	< 2e-16 ***
ot1:groupla:conditionunstressed	3.680e-01	6.377e-02	7.253e+04	5.770	7.95e-09 ***
ot1:grouplb:conditionunstressed	3.157e-01	6.976e-02	7.252e+04	4.526	6.02e-06 ***
ot2:groupla:conditionunstressed	7.170e-02	6.377e-02	7.254e+04	1.124	0.26086
ot2:grouplb:conditionunstressed	3.227e-01	6.976e-02	7.254e+04	4.627	3.72e-06 ***

(interpret later)



1.1.3 Production

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1.2 Duration

1.2.1 Gating

1.2.2 Eye-tracking

1.2.3 Production

1.3 Lexical

1.3.1 Gating

1.3.2 Eye-tracking

1.3.3 Production

2 Study 2: adv, her, nat

2.1 Stress

2.2 Overview

Gating

- all groups predict above chance in both oxytone and paroxytone conditions
- HS overall less accurate than LA and SS (SS > LA = SS), this is due to being sig. less accurate in paroxytone condition
- Condition by wm interaction: higher working memory associated with increased accuracy in the oxytone condition

Eye-tracking

- At target syllable onset:
 - All groups predict above chance in both conditions.
 - In both conditions the LA group differs from the natives (less target fixations).
 - The LA and HS groups do not differ from each other.
- Time course
 - natives fixate on the correct target sooner and at a faster rate.
 - HS focus on target at a faster rate and sooner than LA in paroxytone condition
 - No differences in oxytone condition between LA and HS

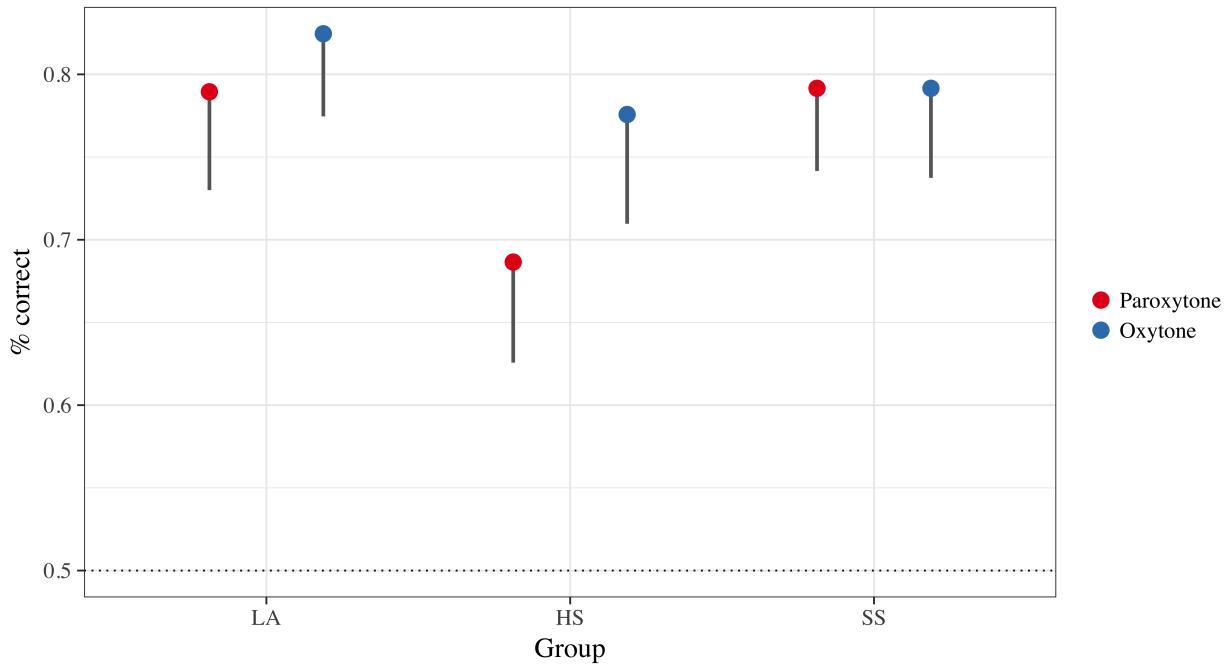
2.2.1 Gating

2.2.1.1 Analyses

2.2.1.1.1 Is stress used to predict morphology? Yes. All groups predict above chance in both conditions.

Group	Condition	Estimate	Statistic	conf.low	df	p.value	sig
S	stressed	0.79	9.97	0.74	24	0.000	*
S	unstressed	0.79	9.21	0.73	24	0.000	*
HS	stressed	0.68	5.26	0.62	22	0.000	*
HS	unstressed	0.77	7.16	0.70	22	0.000	*
LA	stressed	0.78	8.34	0.72	23	0.000	*
LA	unstressed	0.82	11.13	0.77	23	0.000	*

Mean accuracy and lower-bound 95% confidence interval



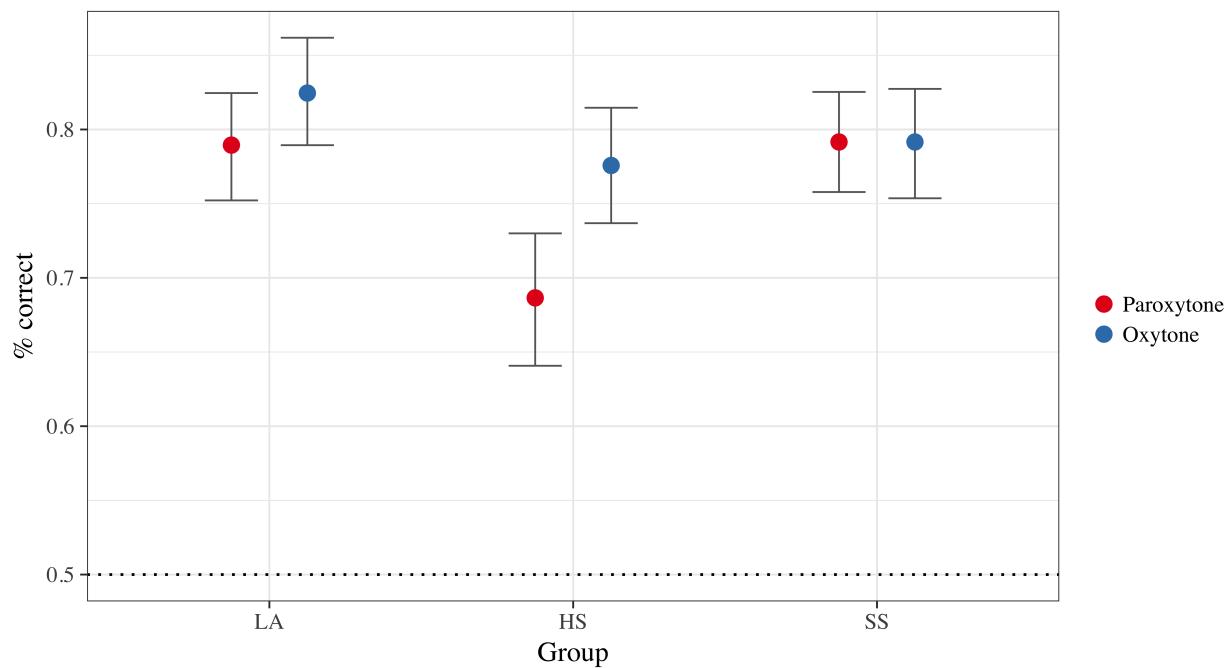
2.2.1.1.2 Do target fixations vary as a function of group and stress at the onset of the target syllable? We use a LMEM to analyze mean accuracy as a function of group, condition and working memory. Main effects and interactions are tested using nested model comparisons.

Model	Df	AIC	BIC	logLik	deviance	Chisq	Chi Df	Pr(>Chisq)
Base	2	2856.7	2868.6	-1426.4	2852.7			
Group	4	2854.5	2878.2	-1423.3	2846.5	6.1930	2	0.045207 *
Condition	5	2849.8	2879.4	-1419.9	2839.8	6.6915	1	0.009687 **
Group x cond.	7	2849.3	2890.7	-1417.7	2835.3	4.4972	2	0.105548
WM	8	2850.8	2898.2	-1417.4	2834.8	0.4941	1	0.482107
condition x wm	9	2848.3	2901.5	-1415.2	2830.3	4.5360	1	0.033189 *

We keep the full model

	Estimate	Std. Error	z value	Pr(>z)
(Intercept)	2.34598	0.68960	3.402	0.000669 ***
GroupHS	-1.07752	0.38018	-2.834	0.004593 **
GroupLA	-0.28208	0.39641	-0.712	0.476728
Condition	-0.78643	0.40270	-1.953	0.050835 .
wm	-0.10125	0.06684	-1.515	0.129845
GroupHS:Condition	0.51122	0.22651	2.257	0.024015 *
GroupLA:Condition	0.28202	0.23642	1.193	0.232916
Condition:wm	0.08350	0.03917	2.132	0.033040 *

Mean accuracy as a function of group and target type

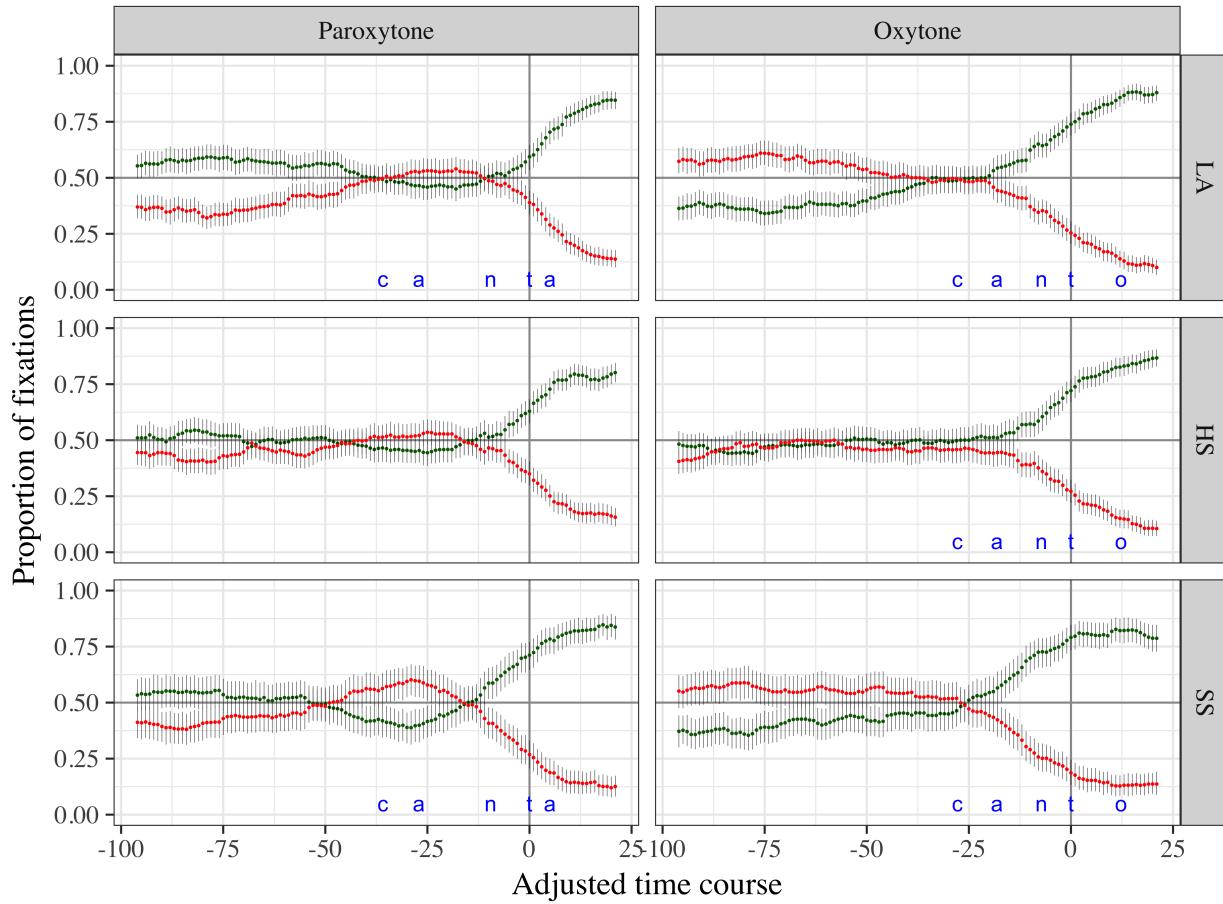


- Main effect of group: HS overall less accurate than LA and SS
- Main effect of condition: HS more accurate in oxytone condition
- Condition by wm interaction: higher working memory associated with increased accuracy in the oxytone condition
- Do HS and LA differ from each other? Yes, HS are less accurate overall

2.2.2 Eye tracking

2.2.2.1 Bin adjustments and centering Same as study 1.

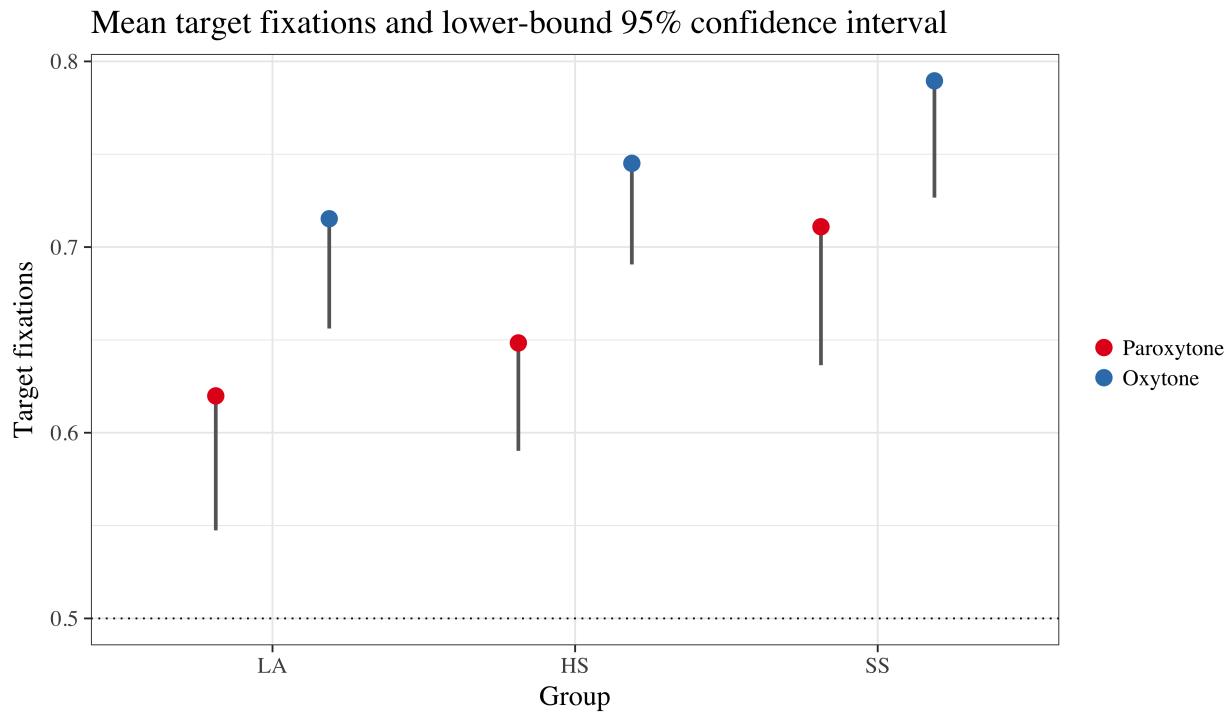
2.2.2.2 Time course plot Proportion of fixations to targets and distractors as a function of group (LA, HS, SS) and word type (paroxytone, oxytone).



2.2.2.3 Analyses

2.2.2.3.1 Is stress used to predict morphology? Yes. All groups predict above chance in both conditions.

Group	Condition	Estimate	Statistic	conf.low	df	p.value	sig
la	stressed	0.61	2.81	0.54	27	0.004	*
la	unstressed	0.71	6.20	0.65	27	0.000	*
hs	stressed	0.64	4.38	0.59	22	0.000	*
hs	unstressed	0.74	7.72	0.69	22	0.000	*
ss	stressed	0.71	4.85	0.63	22	0.000	*
ss	unstressed	0.78	7.90	0.72	22	0.000	*



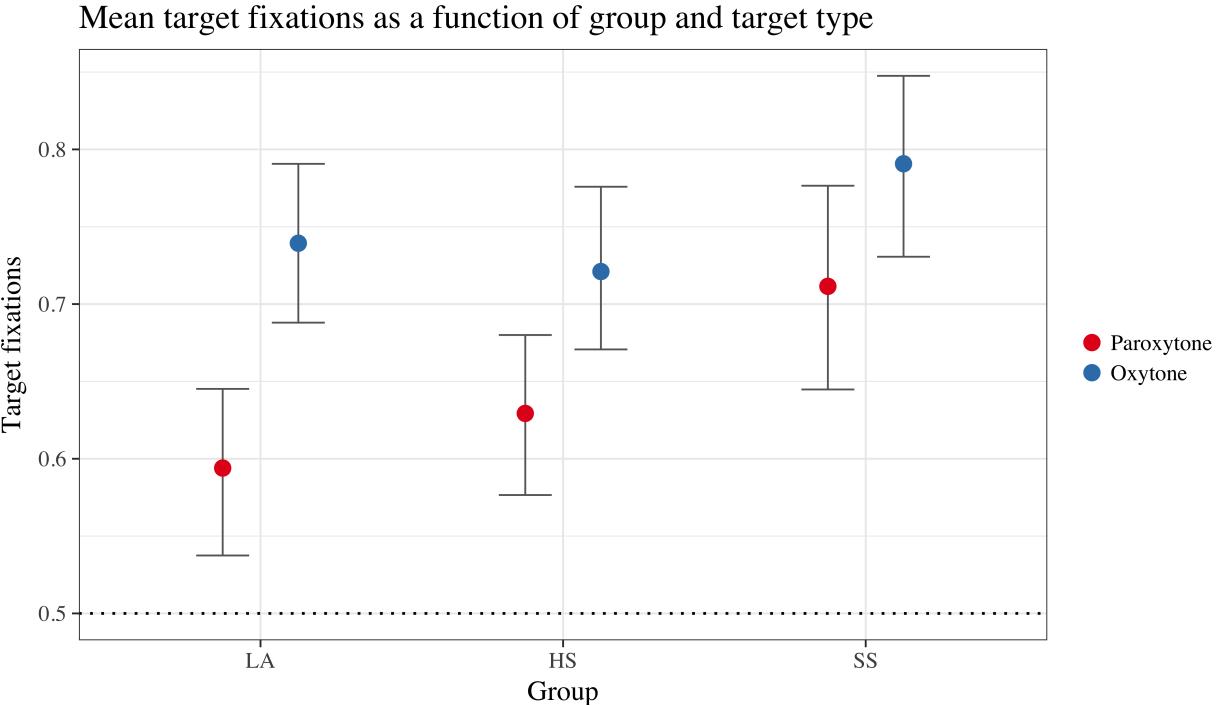
2.2.2.3.2 Do target fixations vary as a function of group and stress at the onset of the target syllable? We use a LMEM to analyze mean target fixations as a function of group, condition and working memory. Main effects and interactions are tested using nested model comparisons.

Model	Df	AIC	BIC	logLik	deviance	Chisq	Chi Df	Pr(>Chisq)
Base	3	-61.83	-52.84	33.91	-67.83			
Group	5	-62.63	-47.64	36.31	-72.63	4.79	2	0.09086 .
Condition	6	-69.36	-51.38	40.68	-81.36	8.73	1	0.00313 **
Group x cond.	8	-65.43	-41.46	40.71	-81.43	0.07	2	0.96447
WM	9	-65.25	-38.28	41.62	-83.25	1.82	1	0.17716
condition x wm	10	-63.57	-33.60	41.78	-83.57	0.31	1	0.57564

There is only a main effect of condition. We refit the model to get parameter estimates.

	Estimate	Std. Error	df	t value	Pr(>t)
(Intercept)	0.70	0.031	109.98	22.27	< 2e-16 ***
groupla	-0.08	0.037	71.00	-2.20	0.03075 *
grouphs	-0.05	0.039	71.00	-1.36	0.17785
conditionunstressed	0.09	0.030	73.00	2.99	0.00379 **

We can now plot the model with upper and lower bound CI.



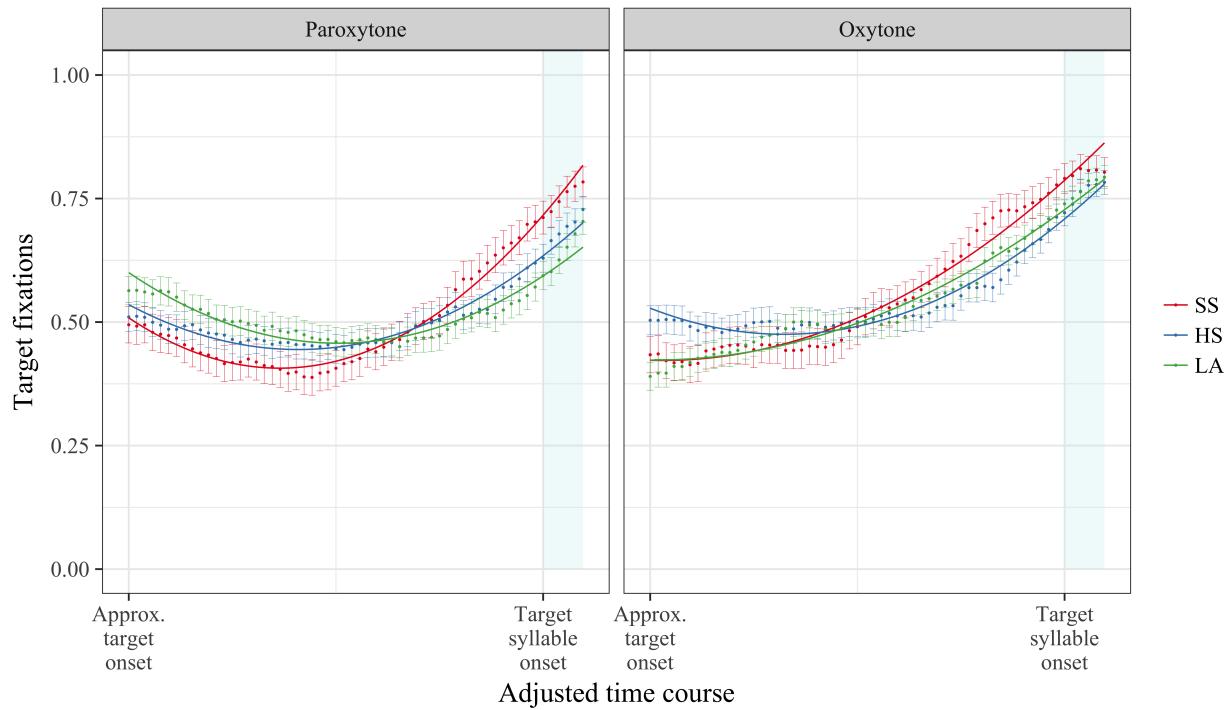
In the stressed and unstressed conditions the LA group differs from the native controls. The HS group does not. The LA and HS groups do not differ from each other.

2.2.2.3.3 Do target fixations vary as a function of group and stress over the time course?
Check main effects and interaction using nested model comparisons. This includes effects of higher order orthogonal polynomials (intercept, linear slope, and quadratic terms).

	Df	AIC	BIC	logLik	deviance	Chisq	Chi Df	Pr(>Chisq)
base model	16	119906	120056	-59937	119874			
Group effect on intercept	18	119909	120079	-59937	119873	0.3100	2	0.8564336
Group effect on linear slope	20	119902	120090	-59931	119862	11.0322	2	0.0040214 **
Group effect on quadratic poly	22	119905	120112	-59931	119861	1.1633	2	0.5589720
Cond. effect on intercept	23	119907	120123	-59931	119861	0.0392	1	0.8430199
Cond. effect on linear slope	24	119898	120124	-59925	119850	11.2161	1	0.0008109 ***
Cond. effect on quadratic poly	25	119895	120130	-59922	119845	5.2366	1	0.0221171 *
Full model	31	119788	120079	-59863	119726	18.9164	6	< 2.2e-16 ***
WM	32	119787	120088	-59862	119723	2.5104	1	0.1130945

We retain the full model and check parameters.

	Estimate	Std. Error	df	t value	Pr(>t)
(Intercept)	5.120e-01	2.511e-02	8.900e+01	20.390	< 2e-16 ***
ot1	6.967e-01	1.119e-01	9.800e+01	6.227	1.18e-08 ***
ot2	5.378e-01	7.306e-02	1.170e+02	7.362	2.74e-11 ***
grouphs	1.903e-03	2.523e-02	7.800e+01	0.075	0.940071
groupla	2.942e-03	2.413e-02	7.800e+01	0.122	0.903257
conditionunstressed	5.430e-02	2.569e-02	3.500e+01	2.114	0.041764 *
ot1:grouphs	-3.025e-01	1.186e-01	8.300e+01	-2.550	0.012617 *
ot1:groupla	-5.618e-01	1.138e-01	8.500e+01	-4.935	3.96e-06 ***
ot2:grouphs	-1.336e-01	8.637e-02	9.300e+01	-1.546	0.125373
ot2:groupla	-1.238e-01	8.330e-02	9.700e+01	-1.486	0.140404
ot1:conditionunstressed	2.832e-01	1.141e-01	4.300e+01	2.483	0.017017 *
ot2:conditionunstressed	-2.668e-01	7.251e-02	7.400e+01	-3.680	0.000439 ***
grouphs:conditionunstressed	-1.119e-02	8.241e-03	8.930e+04	-1.358	0.174495
groupla:conditionunstressed	-2.804e-02	8.186e-03	8.929e+04	-3.426	0.000614 ***
ot1:grouphs:conditionunstressed	-7.199e-02	6.276e-02	8.930e+04	-1.147	0.251314
ot1:groupla:conditionunstressed	4.191e-01	6.234e-02	8.930e+04	6.723	1.79e-11 ***
ot2:grouphs:conditionunstressed	2.410e-01	6.275e-02	8.932e+04	3.841	0.000123 ***
ot2:groupla:conditionunstressed	9.447e-02	6.234e-02	8.931e+04	1.515	0.129673



- Main effect of group on the linear slope: SS > HS = LA
- Main effect of condition on the linear slope: Overall steeper slope in oxytone condition. Faster rate of change.
- Main effect of condition on the quadratic term: Faster rate of change in oxytone condition. Overall earlier looks to target.
- LA and HS groups differ from native controls in the steepness of the slope and the curvature. **Take home message:** native fixate on the correct target sooner and at a faster rate.

How do LA and HS compare to each other?

- Effect of group on linear slope: HS focus on target at a faster rate and sooner than LA in paroxytone condition
- No differences in oxytone condition

2.2.3 Production

2.3 Duration

2.3.1 Gating

2.3.2 Eye-tracking

2.3.3 Production

2.4 Lexical

2.4.1 Gating

2.4.2 Eye-tracking

2.4.3 Production

3 Study 3: adv, int, nat

3.1 Stress

3.1.1 Gating

3.1.2 Eye tracking

3.1.3 Production

3.2 Duration

3.2.1 Gating

3.2.2 Eye-tracking

3.2.3 Production

3.3 Lexical

3.3.1 Gating

3.3.2 Eye-tracking

3.3.3 Production