

Growth Curve Analysis: An Example

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An Example: Semantic Competition

(Mirman & Magnuson, 2009, *Memory & Cognition*)

- “ **Hypothesis**: semantically similar concepts are activated during word comprehension
- “ **Design**: display contains target, a critical competitor, and 2 unrelated distractors
- “ Critical competitors:
 - **Near neighbor**: high semantic similarity (lion-tiger)
 - **Distant neighbor**: low-moderate semantic similarity (lion-beaver)
 - Non-neighbor: no semantic similarity (lion-hammer)

Fitting the model: Competitor fixations

Level 1: $Y_{ij} = \beta_{0i} + \beta_{1i} * Time_j + \beta_{2i} * Time_j^2 + \beta_{3i} * Time_j^3 + \beta_{4i} * Time_j^4 + \epsilon_{ij}$

Level-2

“ Base model: Participant effects on all time terms: LL = 1535

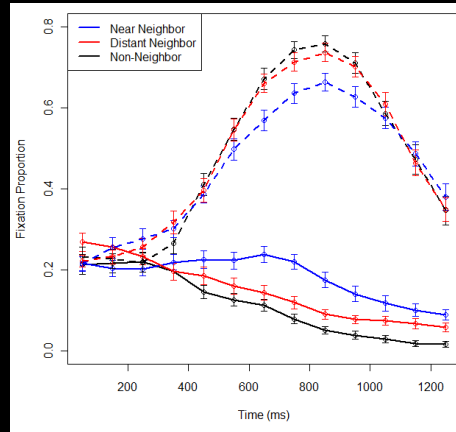
“ $\beta_{Ni} = \gamma_{N0} + \gamma_{Ni} * P_i + \zeta_{Ni}$

“ Non-neighbor is the reference condition, add semantic condition effect on intercept:

“ $\beta_{0i} = \gamma_{00} + \gamma_{0c} * C + \gamma_{0i} * P_i + \zeta_{0i}$

“ LL = 1567, Log Ratio = 65, $\chi^2(2)=65, p < 0.0001$

“ Add effect on slope: LL = 1576, $\chi^2(2)=17, p < 0.001$



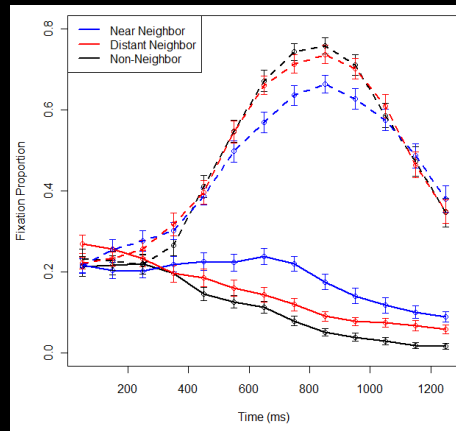
Fitting the model: Competitor fixations

Level 1: $Y_{ij} = \beta_{0i} + \beta_{1i} * Time_j + \beta_{2i} * Time_j^2 + \beta_{3i} * Time_j^3 + \beta_{4i} * Time_j^4 + \epsilon_{ij}$

Level-2

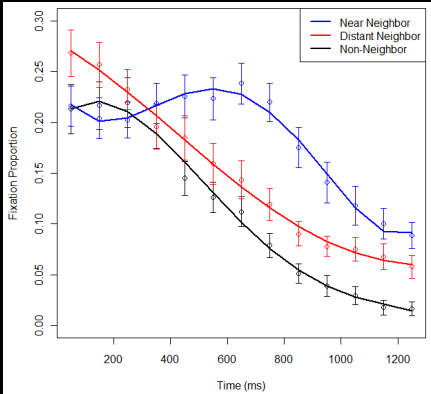
Term	LL	$\chi^2(2)$	$p <$
Base	1535	-	-
β_0	1567	65	0.0001
β_1	1576	17	0.001
β_2	1609	66	0.0001
β_3	1612	6	0.05
β_4	1620	17	0.001

Term	Est.	t	$p <$	Est.	t	$p <$
β_0	.07	6.9	.0001	.04	3.6	.001
β_1	.12	3.7	.001	.02	0.5	n.s.
β_2	-.11	6.1	.0001	.02	1.1	n.s.
β_3	-.04	2.3	.05	-.03	1.6	n.s.
β_4	.07	3.6	.001	.02	0.9	n.s.

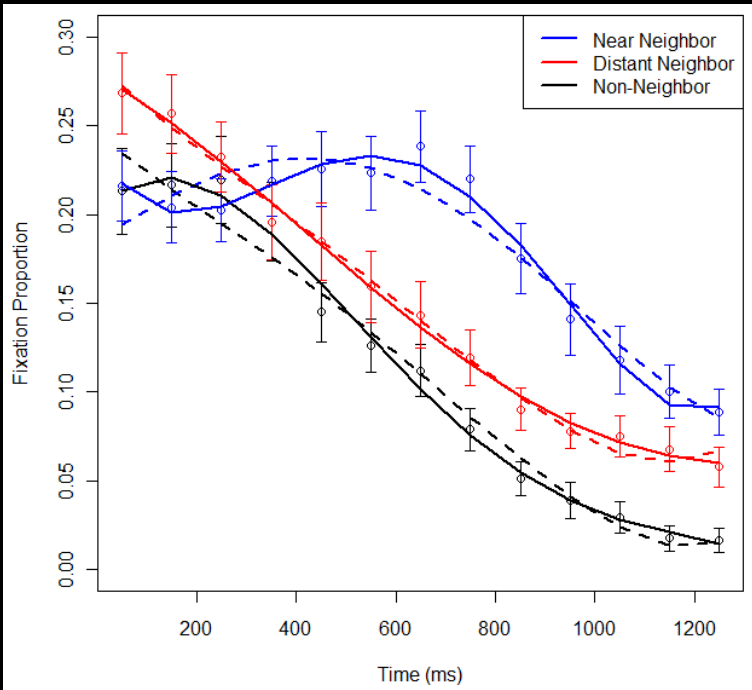
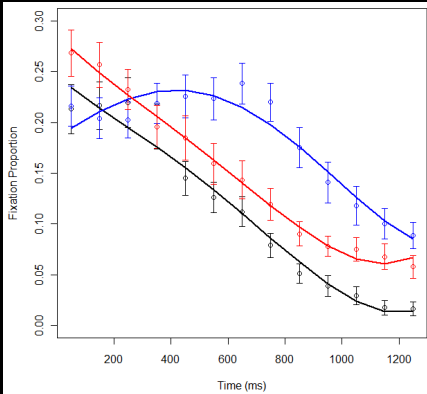


Visual inspection

Full model

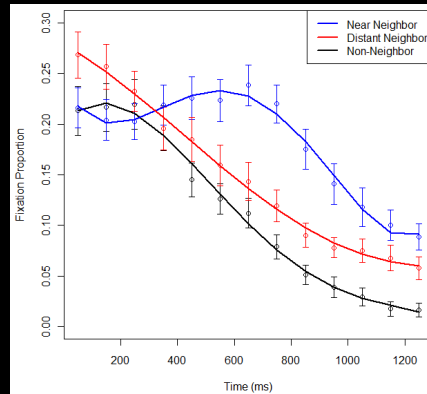


Excluding γ_{3c} and γ_{4c}



Interpreting and reporting results

Term	Est.	t	p <	Est.	t	p <
β_0	.07	6.9	.0001	.04	3.6	.001
β_1	.12	3.7	.001	.02	0.5	n.s.
β_2	-.11	6.1	.0001	.02	1.1	n.s.
β_3	-.04	2.3	.05	-.03	1.6	n.s.
β_4	.07	3.6	.001	.02	0.9	n.s.



- “ Participants were more likely to fixate pictures depicting semantically related concepts than unrelated concepts (β_0)
- “ There was a difference in fixation time course for near neighbors compared to distant neighbors and non-neighbors (β_1, β_2)

The value of continuous covariates

- “ Problem: fixations might be driven by simple visual similarity rather than semantic similarity: lion – tiger > lion – beaver
- “ Solution: Run GCM by items and include visual similarity as covariate
 - Level-2 base model: item effects on all time terms, visual similarity effects on all time terms
 - “ $\beta_{Ni} = \gamma_{N0} + \gamma_{Ni} * i + \gamma_{NV} * V + \zeta_{Ni}$
 - Add semantic similarity condition effects on time terms (Log Ratio > 220, p < 0.0001)
 - “ $\beta_{Ni} = \gamma_{N0} + \gamma_{Ni} * i + \gamma_{NV} * V + \gamma_{Oc} * C + \zeta_{Ni}$
 - Remove visual similarity effects (Log Ratio < 10, n.s.)
 - “ $\beta_{Ni} = \gamma_{N0} + \gamma_{Ni} * i + \gamma_{Oc} * C + \zeta_{Ni}$