Supplemental Materials: Comparing Language Input in Homes of Young Blind and Sighted Children

Erin Campbell

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Contents

Equivalence Testing

To assess whether a lack of statistically significant group differences could be interpreted as genuine equivalence (i.e., that blind and sighted children's input did not differ), we performed two one-sided equivalence tests (TOSTs; Lakens, 2017) for each measure that was non-significant in our primary analyses. Specifically, we tested adult word count, manual word count, conversational turn count, proportion of child-directed speech, type-token ratio, MLU, and proportion of visual words against small ($|d| < 0.3$), moderate ($|d| < 0.5$), and large ($|d| < 0.7$) effect size bounds.

At |d| = 0.3, all TOSTs were inconclusive. We do not have evidence for equivalence at this level and cannot rule out effects of |d|=0.3 or smaller for any of our variables.

At |d| = 0.5, most TOSTs were inconclusive, but we did find a significant TOST for Adult Word Count. This suggests that there is unlikely to be a group difference of |d|≥=0.5 in the number of words that blind and sighted children are exposed to.

At |d| = 0.7, the TOSTs were significant for all but Manual Word Count and Type-Token Ratio. This suggests that there is unlikely to be a difference between blind and sighted children of |d|≥=0.7 in Adult Word Count, Child Vocalization Count, the Proportion of Child-Directed Speech, and the Proportion of Highly Visual Words. We cannot rule out effects of |d|≤=0.7 for Manual Word Count or Type-Token Ratio.

Table 1: Two One-Sided Equivalence Tests at |d|=0.3

Variable	Lower.Bound.Test	Upper.Bound.Test	TOST.Significant.
Adult Word Count	t=1.14, p=0.136	t=-1.18, p=0.128	No
Manual Word Count	t=2.22, p=0.022	t=-0.1, p=0.460	No
Conversational Turn Count	t=1.58, p=0.068	t=-0.74, p=0.235	No
Prop. Child-Directed Speech	t=1.41, p=0.091	t=-0.92, p=0.187	No
Type-Token Ratio	t=0.2, p=0.421	t=-2.12, p=0.026	No
Prop. Highly Visual Words	t=1.94, p=0.036	t=-0.38, p=0.353	No

Table 2: Two One-Sided Equivalence Tests at |d|=0.5

Variable	Lower.Bound.Test	Upper.Bound.Test	TOST.Significant.
Adult Word Count	t=1.92, p=0.038	t=-1.96, p=0.035	Yes
Manual Word Count	t=3, p=0.005	t=-0.88, p=0.198	No
Conversational Turn Count	t=2.35, p=0.017	t=-1.52, p=0.076	No
Prop. Child-Directed Speech	t=2.18, p=0.023	t=-1.69, p=0.056	No
Type-Token Ratio	t=0.98, p=0.173	t=-2.9, p=0.006	No
Prop. Highly Visual Words	t=2.71, p=0.008	t=-1.16, p=0.133	No

Table 3: Two One-Sided Equivalence Tests at |d|=0.7

Variable	Lower.Bound.Test	Upper.Bound.Test	TOST.Significant.
Adult Word Count	t=2.69, p=0.009	t=-2.73, p=0.008	Yes
Manual Word Count	t=3.77, p=0.001	t=-1.65, p=0.060	No
Conversational Turn Count	t=3.13, p=0.004	t=-2.29, p=0.019	Yes
Prop. Child-Directed Speech	t=2.95, p=0.005	t=-2.47, p=0.014	Yes
Type-Token Ratio	t=1.75, p=0.051	t=-3.67, p=0.001	No
Prop. Highly Visual Words	t=3.49, p=0.002	t=-1.93, p=0.037	Yes

Age Interactions

To explore potential developmental trends in children's language input, we fit a series of linear models (each predicting one of our input variables) to investigate whether input characteristics varied by age for blind versus sighted children. We emphasize that these analyses are highly exploratory and should be interpreted with caution.

Quantity

$$\text{Adult Word Count} \sim \text{Age (months)} \times \text{Group (Blind vs. Sighted)}$$

Table 4: Model summary for the linear model predicting Adult Word Count from Age, Group, and their interaction. Estimate and standard error depict the unstandardized effect size (i.e., the number of LENA-estimated adult words/hour). We did not find that Adult Word Count differed significantly across age, by group, or in an age * group interaction.

term	estimate	std.error	statistic	p.value
(Intercept)	831.32	260.89	3.19	.004
groupBlind	515.61	364.94	1.41	.170
Age_months	13.96	14.34	0.97	.339
groupBlind:Age_months	-31.85	20.22	-1.57	.127

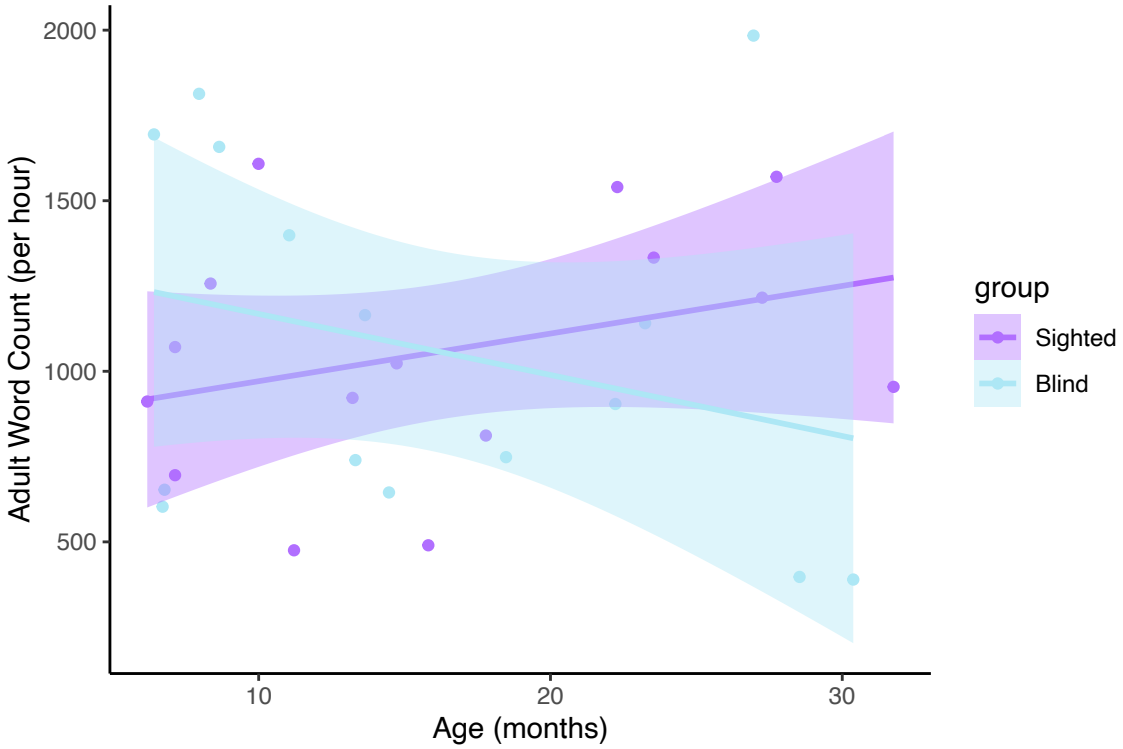

Figure 1: Interaction between age and group on the Adult Word Count (LENA automated measure). Each dot represents the number of words in one child's input.

Manual Word Count ~ Age (months) × Group (Blind vs. Sighted)

Table 5: Model summary for the linear model predicting Manual Word Count from Age, Group, and their interaction. Estimate and standard error depict the unstandardized effect size (i.e., the number of words/hour in the manual annotations). We did not find that Manual Word Count differed significantly across age, by group, or in an age * group interaction.

term	estimate	std.error	statistic	p.value
(Intercept)	2,662.53	545.85	4.88	< .001
groupBlind	-753.27	763.56	-0.99	.333
Age_months	-22.34	30.00	-0.74	.463
groupBlind:Age_months	27.86	42.31	0.66	.516

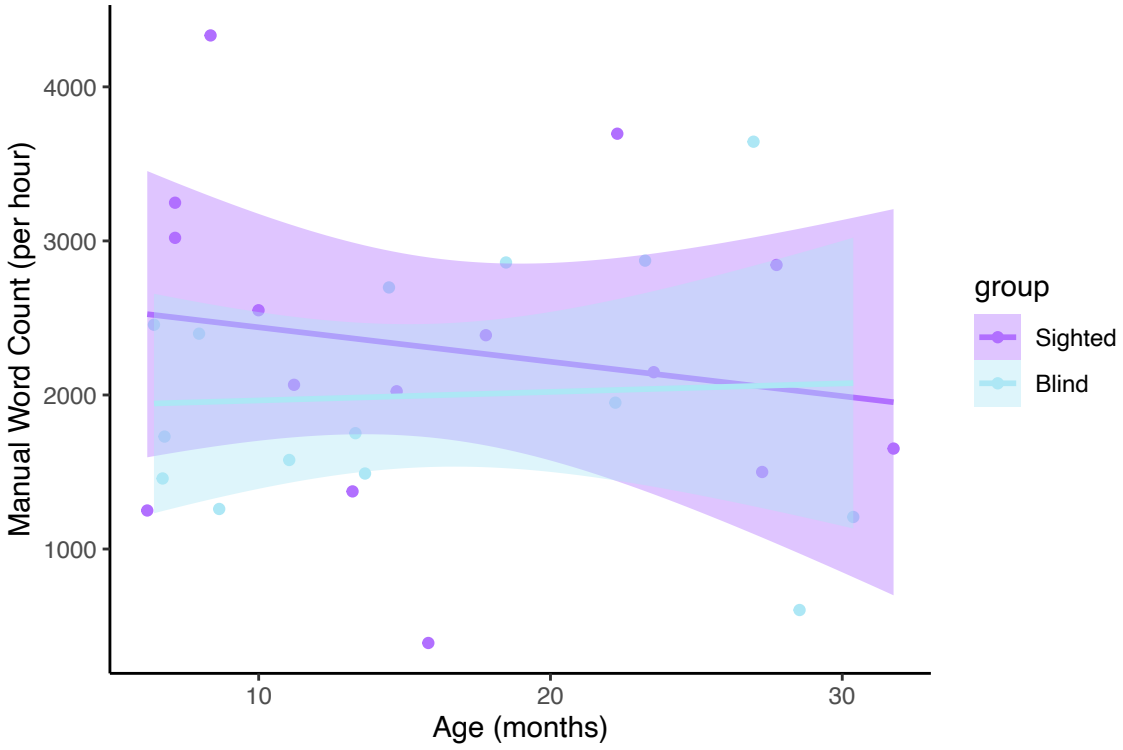

Figure 2: Interaction between age and group on the Manual Word Count (from human annotations). Each dot represents the number of words in one child's input.

Interaction

Conversational Turn Count ~ Age (months) × Group (Blind vs. Sighted)

Table 6: Model summary for the linear model predicting Conversational Turn Count from Age, Group, and their interaction. Estimate and standard error depict the unstandardized effect size (i.e., the number of LENA-estimated conversational turns / hour). Conversational Turn Count increased across age for both groups.

term	estimate	std.error	statistic	p.value
(Intercept)	6.67	10.32	0.65	.524
groupBlind	10.92	14.44	0.76	.456
Age_months	1.78	0.57	3.14	.004
groupBlind:Age_months	-0.81	0.80	-1.01	.323

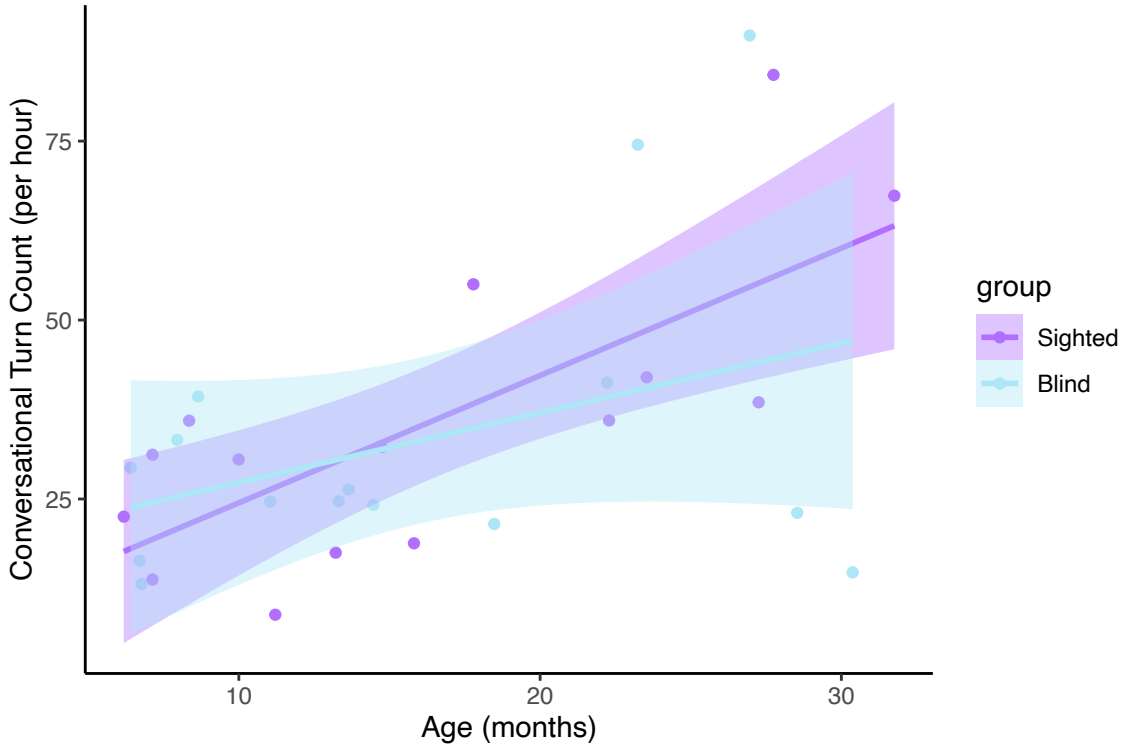

Figure 3: Interaction between age and group on the Conversational Turn Count (LENA automated measure). Each dot represents the number of conversational turns in one child's recording.

Proportion of Child-Directed Speech ~ Age (months) × Group (Blind vs. Sighted)

Table 7: Model summary for the linear model predicting Proportion of Child-Directed Speech from Age, Group, and their interaction. Estimate and standard error depict the unstandardized effect size (i.e., the proportion of child-directed speech). We did not find differences by group, across age, or in an age * group interaction.

term	estimate	std.error	statistic	p.value
(Intercept)	0.39	0.11	3.66	.001
groupBlind	0.05	0.15	0.31	.756
Age_months	0.01	0.01	1.85	.076
groupBlind:Age_months	0.00	0.01	-0.45	.656

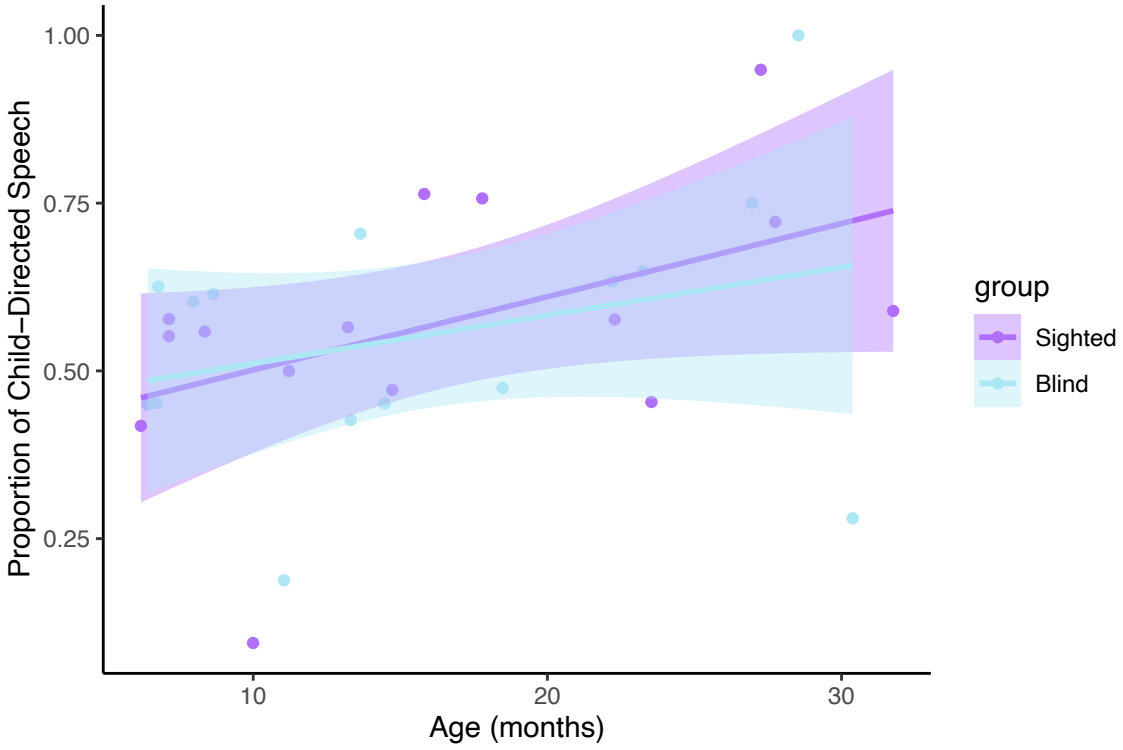

Figure 4: Interaction between age and group on the proportion of child-directed speech. Each dot represents one child's recording.

Linguistic

Type Token Ratio ~ Age (months) × Group (Blind vs. Sighted)

Table 8: Model summary for the linear model predicting Type-Token Ratio from Age, Group, and their interaction. Estimate and standard error depict the unstandardized effect size (i.e., the ratio of unique words : total words). We did not find differences by group, across age, or in an age * group interaction.

term	estimate	std.error	statistic	p.value
(Intercept)	0.60	0.02	33.05	< .001
groupBlind	0.02	0.03	0.61	.550
Age_months	0.00	0.00	1.58	.127
groupBlind:Age_months	0.00	0.00	-0.12	.908

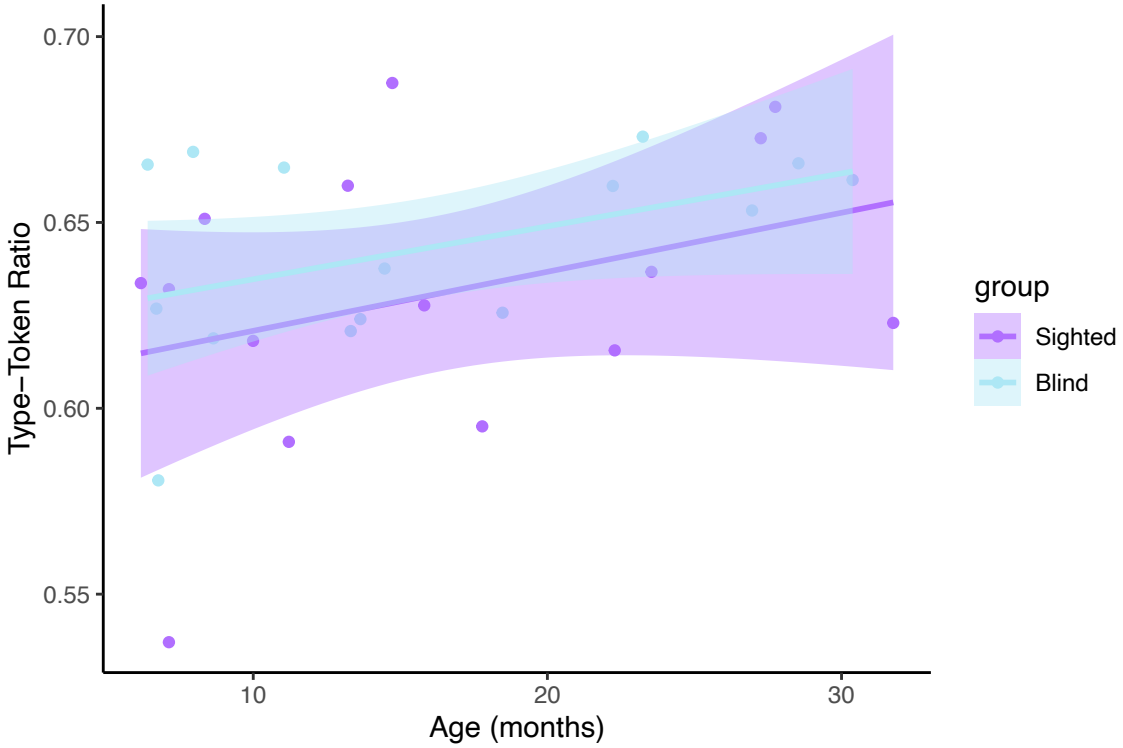

Figure 5: Interaction between age and group on the type-token ratio. Each dot represents one child's recording.

Table 9: Model summary for the linear model predicting MLU from Age, Group, and their interaction. Estimate and standard error depict the unstandardized effect size (i.e., number of morphemes / utterance). We did not find differences by group, across age, or in an age * group interaction.

term	estimate	std.error	statistic	p.value
(Intercept)	4.99	0.48	10.37	$< .001$
groupBlind	-0.07	0.67	-0.11	.912
Age_months	0.00	0.03	-0.04	.971
groupBlind:Age_months	0.04	0.04	1.06	.300

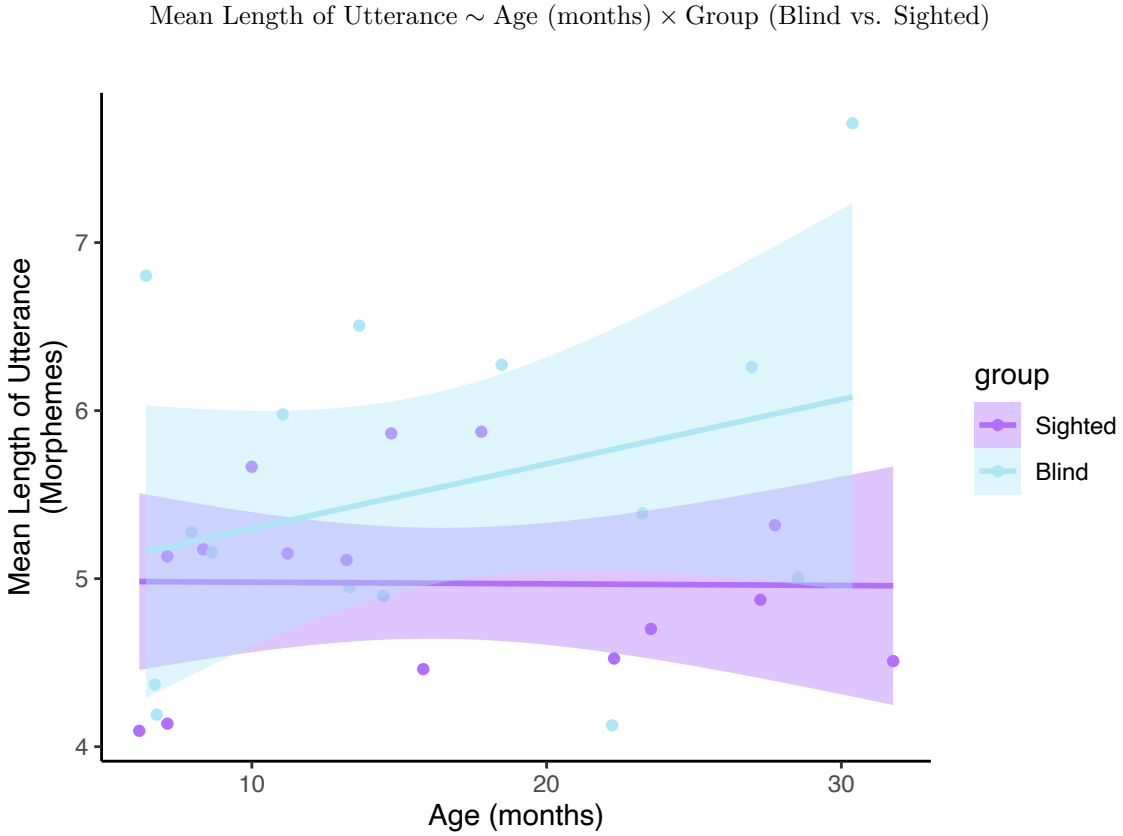

Figure 6: Interaction between age and group on the mean length of utterance. Each dot represents one child's recording.

Conceptual

Proportion of Content Words ~ Age (months) × Group (Blind vs. Sighted) × Sensory Modality

Table 10: Model summary for the linear model predicting the Proportion of Content Words from Age, Group, Word Modality, and their interactions. Estimate and standard error depict the unstandardized effect size (i.e., the proportion of content words). The reference level for Word Modality is Amodal, and the reference level for Group is Sighted. For the main effects, we find no difference between groups, but that some modalities are more common than others. There were no significant interactions between group and modality, however, we did find several two-way interactions between modality and age: the proportions of auditory, gustatory, haptic, interoceptive, multimodal, and olfactory words increased slightly across age for both groups. Intriguingly (and worthy of further research beyond the scope of this exploratory analysis), we observed a three-way interaction between age, group, and word modality. Among sighted children, the proportion of visual words in the input increases significantly more across age than among blind children. The opposite is true for amodal words: which decrease across age for sighted children but not blind children.

term	estimate	std.error	statistic	p.value
Main Effects				
(Intercept)	0.448	0.02	22.96	< .001
ModalityAuditory	-0.393	0.03	-14.26	< .001
ModalityGustatory	-0.447	0.03	-16.22	< .001
ModalityHaptic	-0.447	0.03	-16.21	< .001
ModalityInteroceptive	-0.444	0.03	-16.10	< .001
ModalityMultimodal	-0.013	0.03	-0.46	.645
ModalityOlfactory	-0.447	0.03	-16.18	< .001
ModalityVisual	-0.393	0.03	-14.23	< .001
groupBlind	-0.027	0.03	-0.98	.328
Age_months	-0.004	0.00	-3.65	< .001
Two-Way Interactions				
ModalityAuditory:groupBlind	0.050	0.04	1.30	.194
ModalityGustatory:groupBlind	0.027	0.04	0.69	.492
ModalityHaptic:groupBlind	0.030	0.04	0.77	.444
ModalityInteroceptive:groupBlind	0.028	0.04	0.73	.464
ModalityMultimodal:groupBlind	0.002	0.04	0.06	.954
ModalityOlfactory:groupBlind	0.028	0.04	0.73	.464
ModalityVisual:groupBlind	0.049	0.04	1.27	.206
ModalityAuditory:Age_months	0.004	0.00	2.35	.020
ModalityGustatory:Age_months	0.004	0.00	2.58	.011
ModalityHaptic:Age_months	0.004	0.00	2.64	.009
ModalityInteroceptive:Age_months	0.004	0.00	2.60	.010
ModalityMultimodal:Age_months	0.005	0.00	3.14	.002
ModalityOlfactory:Age_months	0.004	0.00	2.58	.011
ModalityVisual:Age_months	0.007	0.00	4.77	< .001
groupBlind:Age_months	0.003	0.00	1.75	.082
Three-Way Interactions				
ModalityAuditory:groupBlind:Age_months	-0.004	0.00	-1.68	.095
ModalityGustatory:groupBlind:Age_months	-0.003	0.00	-1.24	.217
ModalityHaptic:groupBlind:Age_months	-0.003	0.00	-1.26	.210
ModalityInteroceptive:groupBlind:Age_months	-0.003	0.00	-1.27	.207
ModalityMultimodal:groupBlind:Age_months	-0.002	0.00	-0.93	.353
ModalityOlfactory:groupBlind:Age_months	-0.003	0.00	-1.25	.213
ModalityVisual:groupBlind:Age_months	-0.005	0.00	-2.26	.025

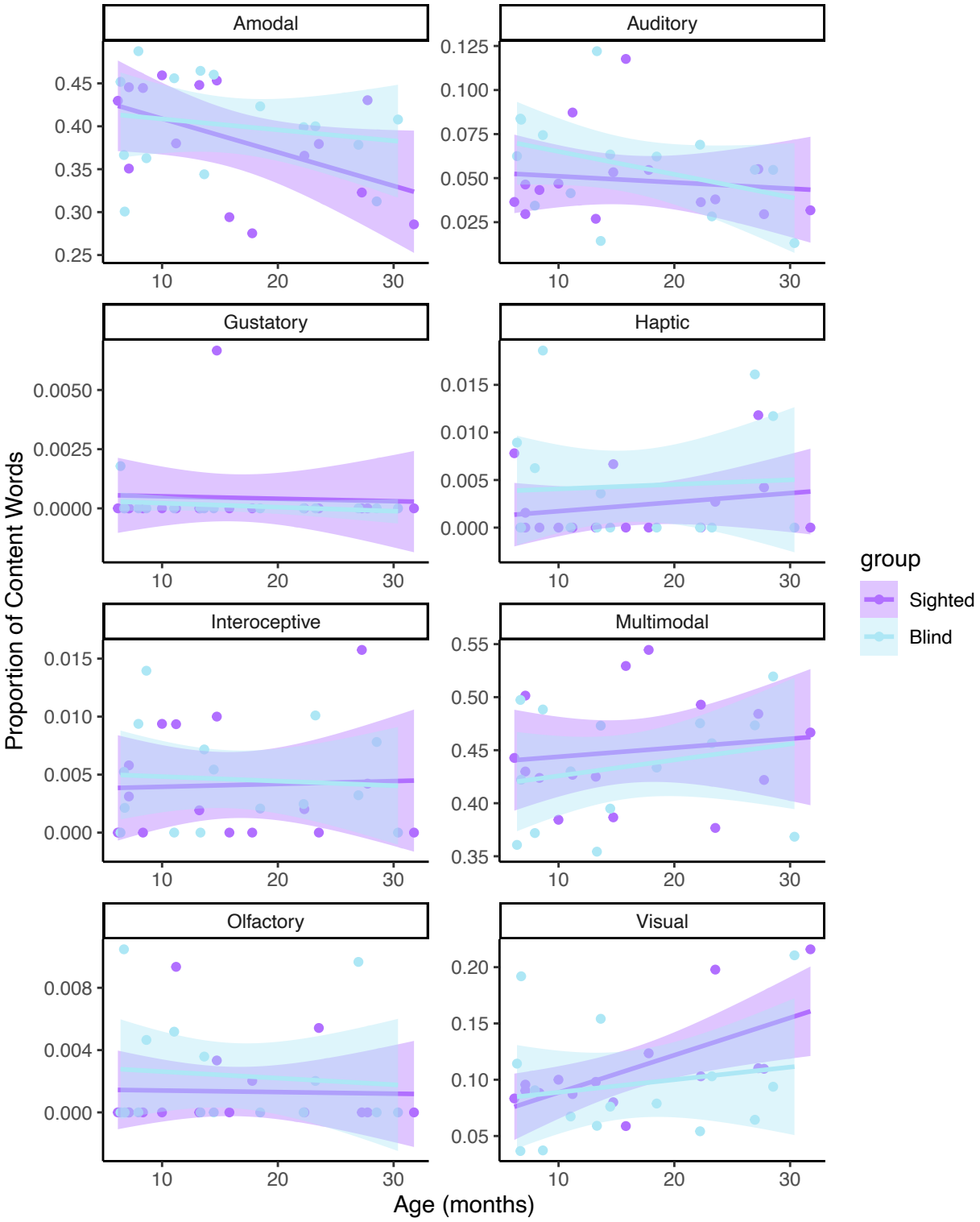

Figure 7: Interaction between age and group on the proportion of words by sensory modality (Lynott & Connell, 2020; see main text for details). Each dot represents one child's recording.

Proportion of Temporally Displaced Verbs ~ Age (months) × Group (Blind vs. Sighted)

Table 11: Model summary for the linear model predicting the Proportion of Temporally Displaced Words from Age, Group, and their interaction. Estimate and standard error depict the unstandardized effect size (i.e., the proportion of verbs). We did not find differences in this proportion by group, across age, or in an age * group interaction. As reported in the main manuscript, we do find an overall group difference in the use of displaced verbs; blind children overall hear more of them than sighted children. We note too that this exploratory model with age does not provide a better fit to the data than a model with just group alone, by model comparison (p=.32)

term	estimate	std.error	statistic	p.value
(Intercept)	0.32	0.03	9.44	$< .001$
groupBlind	-0.01	0.05	-0.30	.765
Age_months	0.00	0.00	-0.89	.384
groupBlind:Age_months	0.00	0.00	1.52	.141

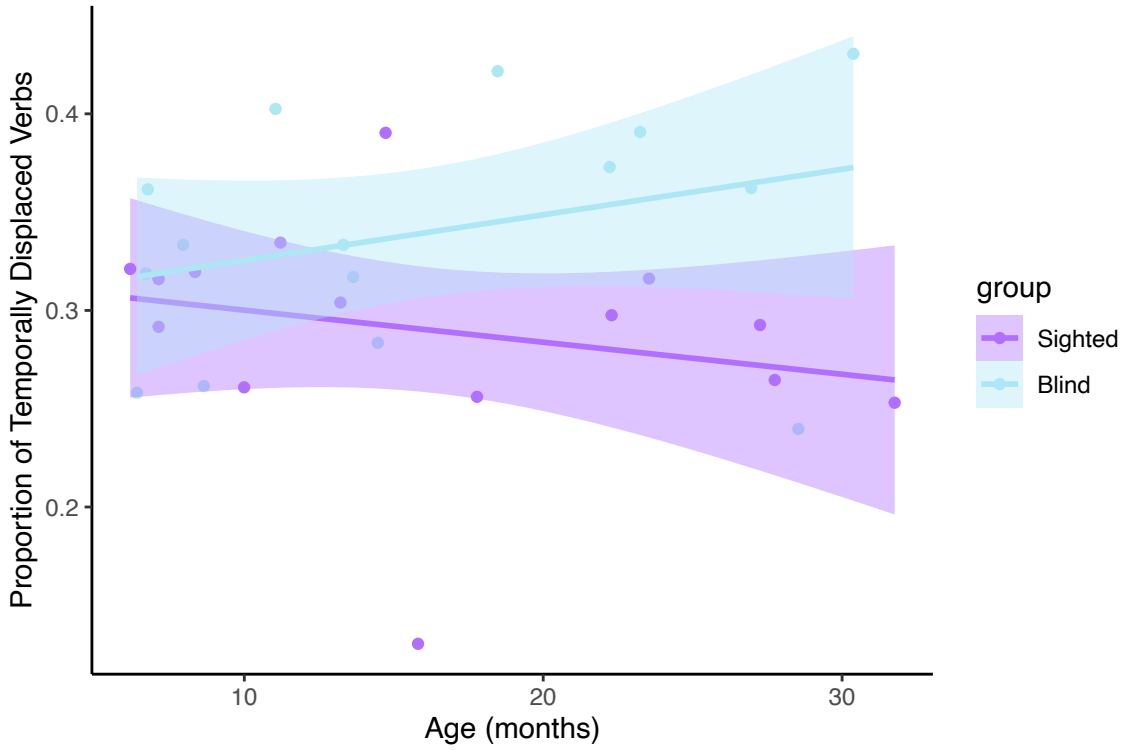

Figure 8: Interaction between age and group on the proportion of temporally-displaced verbs. Each dot represents one child's recording.