



# The Cognitive Neuroscience Laboratory for Language

The web supplement to L. A. Petitto et al. (2000)

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Individuals  
involved in the Brain  
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**Supplemental Material for article  
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[Supplemental Materials: Screening and  
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Supplemental Materials: Six Tables providing a  
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## SUPPLEMENTARY MATERIAL

Petitto, L.A., Zatorre, R.J., Gauna, K., Nikelski, E.J., Dostie, D. & Evans, A.C. (2000). Speech-like cerebral activity in profoundly deaf people while processing signed languages: Implications for the neural basis of human language. *Proceedings of the National Academy of Sciences*. Vol 97, issue 25, pages 13961-13966.

**Screening procedures used for all PET/MRI Subjects.** Two screening procedures were administered to all potential deaf and hearing subjects. The first screening procedure consisted of an extensive questionnaire that was administered to each adult by an interviewer in their native language (a deaf ASL and a deaf LSQ interviewer questioned potential deaf ASL and LSQ Ss, respectively; a hearing English interviewer questioned hearing controls). The questionnaire contained three parts that were asked to all Ss as applicable: (i) Etiology of Deafness (e.g., cause, conditions and degree of deafness; precise dB loss, handedness; age), (ii) Medical and Health History (e.g., no drug use; no serious head traumas; no heart illness; no diabetes; no previous meningitis; no history of psychiatric problems), and (iii) Family, Language, and Educational History (e.g., occupation; past and present language(s) used in the home; age when first entered school, nature of schooling and highest level achieved; language of schooling; knowledge of other languages; deafness in family; member of deaf social club/greater deaf community; knowledge and degree of use of a spoken language and/or another signed language).

The second screening procedure consisted of two parts: the "Koumal" and "Language Fluency" Tasks. The Koumal Task consisted of two non-verbal cartoons (1.5 mins each) previously standardized with deaf signers and hearing speakers across two different countries involving four different languages (two spoken, two signed) to assess language fluency, level of linguistic competence, and presence of other neurological disorders<sup>1</sup>. Potential deaf and hearing Ss viewed the Koumal cartoons and re-told the story to interviewers native in their respective languages, and whom Ss presumed had not seen the cartoon. Coding of number of events reported per story were made, with reliability measures taken, and enabled us to differentiate true native versus non-native signers/speakers, establish a baseline "signed language fluency" measure analogous to "verbal fluency" in hearing controls, and establish absence of other neurological or cognitive deficits. In the Language Fluency Tasks, potential Ss were given three categories of items--"Animals," "Vegetables," "Clothing"--and were asked to generate as many words (hearing) or signs (deaf) as they could for each category within 2 minutes each. In the two Koumal Tasks combined (3 minutes), selected deaf Ss averaged 65 events recalled (range 35-90) and hearing averaged 50 (range 35-64), and in the 2-min Language Fluency Tasks, deaf Ss generated on average 32 Animals (range 23-44), 36 Clothing (range 20-45), 19 Vegetables (range 9-32), and hearing averaged 37 Animals (range 17-52), 36 Clothing (range 23-50), 26 Vegetables (range 12-37).

**Psycholinguistic Experimental Procedures.** That our sign-phonetic stimuli indeed contained true meaningless phonetic and syllabic was established in 3 ways (for each of the two sign languages, ASL, LSQ): (i) Phonetic units were selected from the published inventories of ASL<sup>2</sup> and LSQ<sup>3,4</sup>, and formed into syllabic units as per published analyses of the sign-syllable<sup>5,6</sup>, (ii) Using standard psycholinguistic methods, extensive pilot testing was then conducted whereby potential ASL and LSQ phonetic/syllabic stimuli were administered to ASL and LSQ native deaf signers (respectively), who were different from those to be scanned, and asked to rate the stimuli along several dimensions including whether the form was meaningful and existed in their language, meaningless and not in their language but a form that could potentially exist, or meaningless and not in their language and contained formational violations such that the form could not exist in a natural signed language; only the second category of forms were included in the final ASL and LSQ stimuli sets. (iii) Representative videotaped samples of the phonetic/syllabic stimuli were sent to an independent laboratory where a scholar in the linguistic/syllabic structure of signed languages viewed the videotape and confirmed that the stimuli contained phonetic/syllabic units organized into meaningless but well-formed nonsense forms (Dr. David Perlmutter, personal communication).

1. Kegl, J. (1994) *Signpost: Internatl. Quarterly of the Sign Linguistics Assoc.* **7**, 24-31.
2. Klima, E. S. & Bellugi, U. (1979) *The signs of language* (Harvard Univ. Press, Cambridge).
3. Bourcier, P. & Roy, J. E. (1985) *La langue des signes (LSQ)* (Bibliothèque Nationale du Québec / Canada, Montréal).
4. Petitto, L. A., Charron, F., & Brière, S. (1990) Étude de la phonologie de la Langue des Signes Québécoise (LSQ). *Technical Reports in Cognitive Science* **7** (McGill University, Montréal).
5. Brentari, D. (1999) *A Prosodic Model of Sign Language Phonology* (MIT Press, Cambridge).
6. Perlmutter, D. (1992) *Linguistic Inquiry* **23**, 407-442.

**Tables 3 - 8.** Six tables appear below (in six separate PDF files) that contain the full report of the coordinates from the subtractions provided in the text's two Tables as well as Fig. 1, I.



Table 4.

Verb - Imitation

ASL					LSQ					Hearing 1					Hearing 2				
#	x	y	z	t	#	x	y	z	t	#	x	y	z	t	#	x	y	z	t
1	-46	32	2	5.15	1	-34	24	-9	6.55	1	0	41	-17	6.86	1	-59	-26	-2	6.62
2	-55	-47	-17	5.10	2	-47	25	21	5.17	2	-47	27	0	6.56	2	-35	29	-3	6.28
3	35	27	-2	4.98	3	-55	-31	0	4.63	3	-5	34	51	6.44	3	-3	42	29	6.23
4	-46	20	30	4.55	4	-29	56	-2	4.33	4	16	56	-2	6.16	4	-27	-93	-2	6.18
5	-31	22	3	4.38	5	-9	27	38	4.32	5	-38	32	-11	6.14	5	-9	56	35	6.15
6	-4	34	42	3.97	6	-59	-44	-15	4.29	6	-8	63	14	5.72	6	-3	44	50	5.66
7	27	58	-3	3.86	7	32	22	-11	4.25	7	-5	30	35	5.56	7	-11	39	56	5.46
8	-35	-68	-20	3.69	8	-12	27	-21	4.17	8	-59	-42	-6	5.46	8	-1	46	6	5.25
9	8	32	32	3.66	9	-17	-83	-23	3.92	9	-51	8	-17	5.38	9	21	37	53	5.24
10	9	-81	-18	3.61	10	7	37	-17	3.74	10	-20	-95	-8	5.37	10	-5	22	-17	5.02
11	-32	55	9	3.52	11	-34	-64	45	3.52	11	28	-93	0	5.26	11	-54	-64	36	4.98
12	52	20	12	3.46	12	-1	-97	45	3.43	12	-27	48	-5	4.97	12	-29	29	54	4.84
13	20	1	24	3.30	13	-13	12	6	3.39	13	-55	-26	5	4.97	13	15	58	-14	4.76
14	-11	22	-14	3.16	14	1	36	23	3.36	14	-5	42	14	4.66	14	24	-97	-2	4.74
15	42	-59	-21	3.09	15	51	22	35	3.34	15	-25	17	-20	4.56	15	-25	61	12	4.52
16	20	22	-20	3.05	16	52	-52	-18	3.34	16	-56	-13	-6	4.41	16	13	29	-14	4.49
17	-66	-49	-2	3.00	17	43	36	-9	3.34	17	19	34	-12	4.39	17	12	20	-14	4.48
18	62	-64	47	2.98	18	-4	12	63	3.31	18	-52	-16	-20	4.36	18	64	-23	3	4.46
19	-25	49	-11	2.94	19	27	-64	-24	3.20	19	-48	15	38	4.34	19	9	10	9	4.38
20	-50	-52	53	2.91	20	44	-68	-21	3.19	20	-27	20	62	4.33	20	-12	58	-14	4.38
21	21	-52	6	2.82	21	15	22	-15	3.12	21	11	-4	-21	4.28	21	60	-31	0	4.31
22	-46	-83	8	2.75	22	67	-42	-5	3.09	22	36	18	-9	4.16	22	-40	3	-20	4.25
23	-44	-83	8	2.75	23	-35	-4	42	3.06	23	1	-9	12	4.08	23	29	53	3	4.19
24	-29	15	50	2.75	24	3	32	51	3.00	24	39	36	-6	4.05	24	-56	-7	-21	3.98
25	-32	-71	-5	2.71	25	66	-31	60	2.98	25	55	-28	6	4.04	25	36	15	-17	3.85
26	12	-88	11	2.67	26	36	-74	60	2.96	26	60	-23	2	3.94	26	-50	-56	50	3.84
27	19	-83	3	2.61	27	-4	-80	-23	2.96	27	13	51	42	3.87	27	-54	13	-21	3.81
28	21	53	27	2.61	28	40	60	2	2.91	28	25	6	26	3.73	28	12	-87	-23	3.79
29	-8	-2	-8	2.51	29	-24	1	-6	2.89	29	43	17	8	3.69	29	-50	5	-23	3.71
30	-20	-59	47	2.51	30	3	-28	-11	2.88	30	51	1	-12	3.64	30	-54	-4	26	3.63
					31	54	42	9	2.88	31	27	55	33	3.57	31	0	37	-17	3.59
					32	19	61	9	2.84	32	-24	17	20	3.52	32	46	-35	0	3.58
					33	46	-92	-2	2.70	33	-38	-18	-14	3.42	33	-34	-18	-18	3.58
					34	-43	-47	17	2.67	34	51	-16	-15	3.39	34	1	-47	30	3.55
					35	28	-95	-15	2.66	35	1	-49	30	3.34	35	3	-11	-11	3.50
					36	58	17	53	2.64	36	-21	-9	29	3.18	36	40	15	62	3.48
					37	24	-88	-23	2.62	37	51	8	62	3.12	37	-24	48	45	3.43
					38	20	36	-8	2.58	38	-8	-1	0	3.07	38	-39	22	44	3.38
					39	13	15	3	2.54	39	-29	-44	15	3.01	39	-3	3	-6	3.37
										40	-28	-13	-20	3.01	40	-7	-47	38	3.33
										41	-24	-35	18	2.91	41	-13	12	2	3.31
										42	15	60	26	2.79	42	56	-13	-8	3.27
										43	-43	-62	42	2.72	43	-4	-4	-21	3.14
										44	64	-66	47	2.71	44	3	-21	12	3.07
										45	-31	-54	29	2.64	45	34	-78	-24	3.04
										46	19	25	60	2.58	46	62	-7	12	2.99
										47	51	-9	32	2.57	47	-13	6	15	2.88
										48	11	36	29	2.53	48	48	20	-2	2.59
										49	23	-95	62	2.50	49	56	6	-15	2.56
										50	-46	-95	48	2.51	50	-46	-95	48	2.51

Table 5.

Verb - View signs

ASL					LSQ					Hearing 1					Hearing 2				
#	x	y	z	t	#	x	y	z	t	#	x	y	z	t	#	x	y	z	t
1	-8	-71	12	4.64	1	5	-62	-15	6.51	1	-1	17	47	7.54	1	-4	18	48	5.67
2	-35	18	8	4.53	2	-46	20	14	5.93	2	-46	20	5	7.08	2	-52	-1	30	5.55
3	-12	-74	41	4.44	3	-15	-74	47	5.31	3	39	13	3	4.98	3	-9	10	65	5.32
4	4	30	29	4.35	4	-25	-2	65	4.83	4	-44	8	27	4.84	4	-34	-92	-2	4.67
5	-47	-54	-21	3.86	5	-3	8	65	4.66	5	27	-93	0	4.65	5	-42	25	3	4.61
6	0	-61	-18	3.83	6	-1	17	51	4.60	6	-40	36	23	4.42	6	-1	32	30	4.48
7	32	-59	-23	3.65	7	-24	-50	65	4.04	7	-55	-31	8	3.60	7	-60	-23	3	4.40
8	-28	-4	63	3.54	8	-36	-2	50	3.85	8	1	-16	11	3.53	8	-43	24	27	3.60
9	-19	-61	47	3.48	9	-3	-9	63	3.73	9	-1	-52	-17	3.35	9	17	12	65	3.50
10	-50	-71	17	3.43	10	1	-33	-15	3.64	10	-25	49	-15	3.26	10	-4	-54	-14	3.39
11	-21	-28	17	3.42	11	-55	-50	-2	3.62	11	7	-23	-9	3.16	11	-12	8	8	3.37
12	-52	-42	32	3.42	12	-28	-107	6	3.60	12	12	-66	17	3.08	12	-62	12	-20	3.36
13	-7	5	65	3.40	13	-23	-26	62	3.54	13	-8	-9	-2	3.07	13	36	-74	-23	3.35
14	-42	18	35	3.39	14	27	-62	-26	3.37	14	-12	-59	2	3.05	14	-24	53	12	3.32
15	60	24	-15	3.36	15	43	24	0	3.34	15	15	-69	-23	2.84	15	42	-38	5	3.32
16	7	-88	42	3.26	16	46	-56	-24	3.22	16	-31	-68	47	2.84	16	21	51	35	3.26
17	-28	44	30	3.18	17	-35	-42	47	3.18	17	-23	-97	-6	2.81	17	4	-19	2	3.24
18	-25	-37	62	3.16	18	12	-13	-2	3.15	18	48	-9	39	2.76	18	-19	51	24	3.23
19	-19	-49	66	3.14	19	-28	-66	45	3.14	19	-16	-11	26	2.72	19	27	-95	-5	3.13
20	7	-69	20	2.96	20	-28	49	20	3.07	20	-46	30	-23	2.71	20	56	-6	29	3.12
21	68	8	-2	2.81	21	-48	-62	-20	3.07	21	17	12	66	2.67	21	-15	53	35	3.10
22	63	25	6	2.79	22	-38	-16	54	2.97	22	62	15	-9	2.67	22	-54	18	-11	3.02
23	1	-37	-18	2.65	23	28	-93	65	2.78	23	-15	48	26	2.64	23	-31	12	50	2.89
24	-32	51	14	2.64	24	-51	-33	27	2.77	24	-62	-44	-11	2.64	24	-11	-59	0	2.83
25	-5	-14	20	2.54	25	-13	10	5	2.77	25	54	-4	33	2.62	25	47	-7	47	2.83
					26	28	-97	56	2.73	26	40	-66	60	2.60	26	-7	-83	48	2.82
					27	43	-100	6	2.56	27	-64	15	30	2.58	27	17	58	-12	2.79
					28	-15	12	21	2.51	28	-21	53	56	2.52	28	46	15	5	2.76
															29	0	-7	11	2.68
															30	12	-73	63	2.64
															31	34	17	-3	2.64
															32	-13	63	-8	2.64
															33	-56	8	-9	2.62

Table 6.

View signs - Fixation

ASL					LSQ					Hearing 1					Hearing 2				
#	x	y	z	t	#	x	y	z	t	#	x	y	z	t	#	x	y	z	t
1	16	-92	9	7.07	1	40	-74	-2	6.78	1	40	-74	-2	6.02	1	44	-71	5	5.31
2	-1	-85	-2	6.44	2	0	-90	5	6.00	2	11	-93	9	5.83	2	4	-93	9	5.13
3	-48	-74	5	5.26	3	17	-93	5	5.94	3	-36	-78	-6	5.71	3	-40	-61	-12	4.19
4	25	-30	51	5.12	4	-40	-47	-17	5.68	4	23	-88	18	5.04	4	-11	-85	8	4.18
5	46	-37	8	4.43	5	20	-83	-8	5.24	5	-4	-90	-9	4.96	5	-42	-76	-6	3.85
6	-34	-23	57	4.35	6	-46	-71	-2	5.19	6	-15	-97	14	4.49	6	-43	12	42	3.84
7	29	32	-17	3.68	7	-63	12	-11	4.78	7	-21	-92	5	4.44	7	21	-88	24	3.73
8	-35	-81	-8	3.42	8	-47	-59	8	4.77	8	-47	-74	5	4.15	8	-24	24	56	3.66
9	-24	-92	9	3.39	9	40	-38	3	4.31	9	50	-59	6	3.86	9	3	13	63	3.61
10	7	-21	66	3.13	10	38	-47	-17	4.22	10	24	-80	-15	3.73	10	-50	-66	21	3.60
11	-50	-16	-6	3.11	11	-67	-7	0	3.89	11	-20	-4	-23	3.71	11	-25	3	-18	3.54
12	40	-62	-17	2.95	12	1	-37	30	3.73	12	8	-80	-18	3.66	12	31	-19	56	3.49
13	16	-4	57	2.77	13	-16	-85	-2	3.64	13	23	-25	35	3.12	13	-13	34	56	3.41
14	12	15	29	2.58	14	-24	-38	57	3.62	14	-20	34	5	3.05	14	-12	37	56	3.41
15	-11	-1	56	2.58	15	58	32	20	3.51	15	-43	-33	-20	2.97	15	-48	46	-3	3.37
16	-42	3	48	2.58	16	-54	25	-21	3.51	16	20	18	23	2.92	16	11	44	47	3.35
17	31	-14	57	2.52	17	54	-42	9	3.27	17	17	24	11	2.87	17	-52	22	26	3.33
18	-55	-28	8	2.52	18	-9	70	11	3.17	18	-58	6	-12	2.85	18	4	-31	26	3.27
					19	-7	-50	11	3.10	19	-12	-57	-21	2.85	19	-38	27	-21	3.04
					20	21	-73	45	3.06	20	-25	-31	44	2.83	20	-35	-50	54	2.97
					21	17	-95	54	3.04	21	-38	-49	-15	2.83	21	0	56	35	2.73
					22	-28	-11	42	2.84	22	-31	-54	11	2.81	22	19	30	54	2.72
					23	-12	53	48	2.79	23	-35	-62	59	2.74	23	-39	-40	-15	2.69
					24	1	70	50	2.72	24	1	3	-5	2.74					
					25	0	-42	-5	2.69	25	-31	-49	62	2.69					
					26	59	6	-15	2.67	26	-60	30	-15	2.69					
					27	7	-44	68	2.67	27	-28	-25	2	2.62					
					28	-17	-28	-24	2.66	28	-7	12	66	2.58					
					29	-58	-33	6	2.63	29	-56	-9	23	2.57					
					30	-62	-44	-11	2.57	30	-1	-35	-2	2.54					
										31	-39	6	-21	2.53					
										32	34	-35	23	2.51					





