

Phonetic Conditioning of Lowering in American Sign Language

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Lowering of High Signs in ASL

- A class of signs articulated with contact at the forehead can move down to make contact with the cheek.
 - KNOW, FOR
- Similarly, signs articulated in front of the forehead can shift downward in the signing space.
 - WHY, WONDER

Lowering of Forehead Signs

- Liddell & Johnson (1989)
 - Lowering is more common in casual signing
 - Neighboring signs may trigger lowering
- Lucas et al. (2002)
 - Lowering in conversational data
 - A preceding high sign tends to inhibit lowering
 - Strongest predictor: grammatical category
 - Phonetic location was not measured precisely
- Russell et al. (2010)
 - Lowering can be categorical or gradient
 - Undershoot is planned rather than accidental

Method: Participants

- 4 signers: 3 female, 1 male
- Native Deaf adult signers
- All right-handed
- No known neurological or communication disorders

Method: ASL Target Signs

Reported to lower:



KNOW



WHY

Not reported to lower:



FATHER



STUBBORN

Method: Procedure

Participants produced a target sign embedded in either a high carrier phrase or a low carrier phrase.

High:

PICTURE (index) FATHER SEE?

Low:

PICTURE (index) FATHER RIGHT?

Utterances were produced 15 times, at 3 signing speeds. The data we present are for 10 productions at each speed.

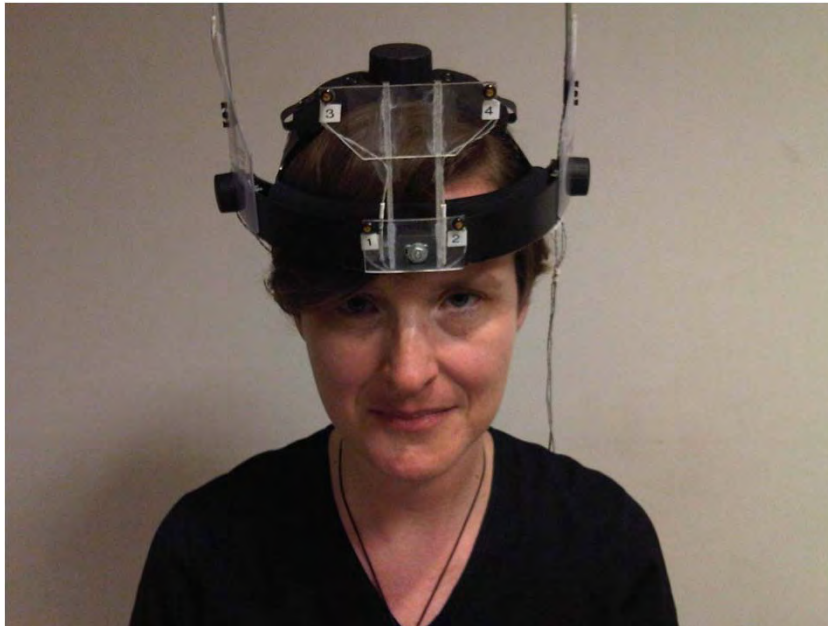
Method: Data Capture



Optoelectronic Data Capture

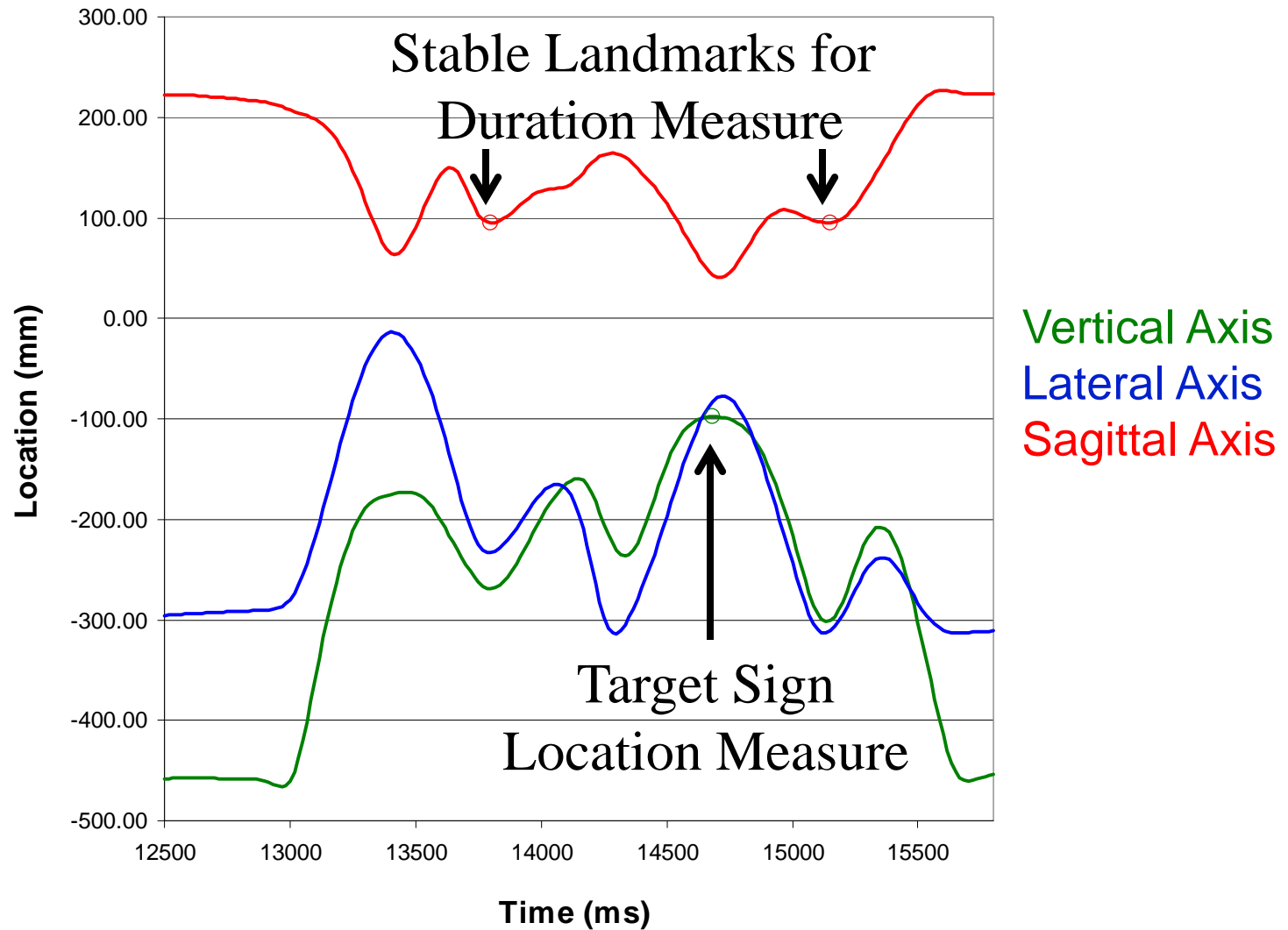
- Tracks light-emitting markers that are attached to a subject's articulators.
- Early use dates back over 20 years (e.g. Wilbur 1990, Poizner et al. 1987), and has recently seen more widespread use.

Tracking the Sign Articulators



- 2 markers are placed on the dorsal and ulnar sides of the hand
- 6 markers on the head allow it to be tracked as a 3D rigid body
- Positional data for the hand are converted to head-centered coordinates

Positional Data



Evaluating Environment Effects

- Location measurements from the slowest rate condition were analyzed to determine if there were environment effects independent of rate.
- Target signs were expected to be lower in the low environment than in the high environment.
- We conducted a series of one-way ANOVAs with location as dependent variable and phonetic environment (low vs. high) as independent variable.
- Statistics are available for scrutiny.

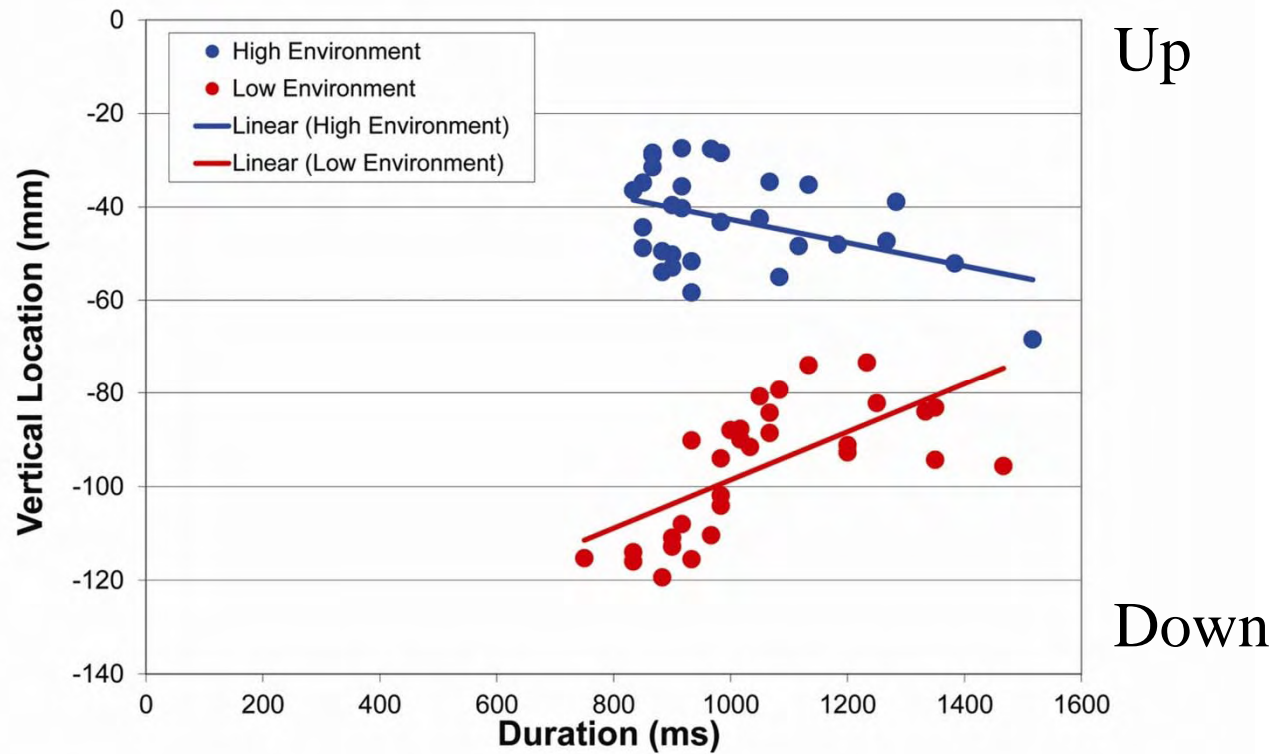
Summary of Environment Effects

- In 7 out of 14 comparisons, the target sign was lower in the low phonetic environment.
- In only 2 comparisons was the target sign higher in the low environment and the difference was relatively small.
- Unexpected differences were found along the horizontal axes, but no consistent patterns were evident across signs or signers.

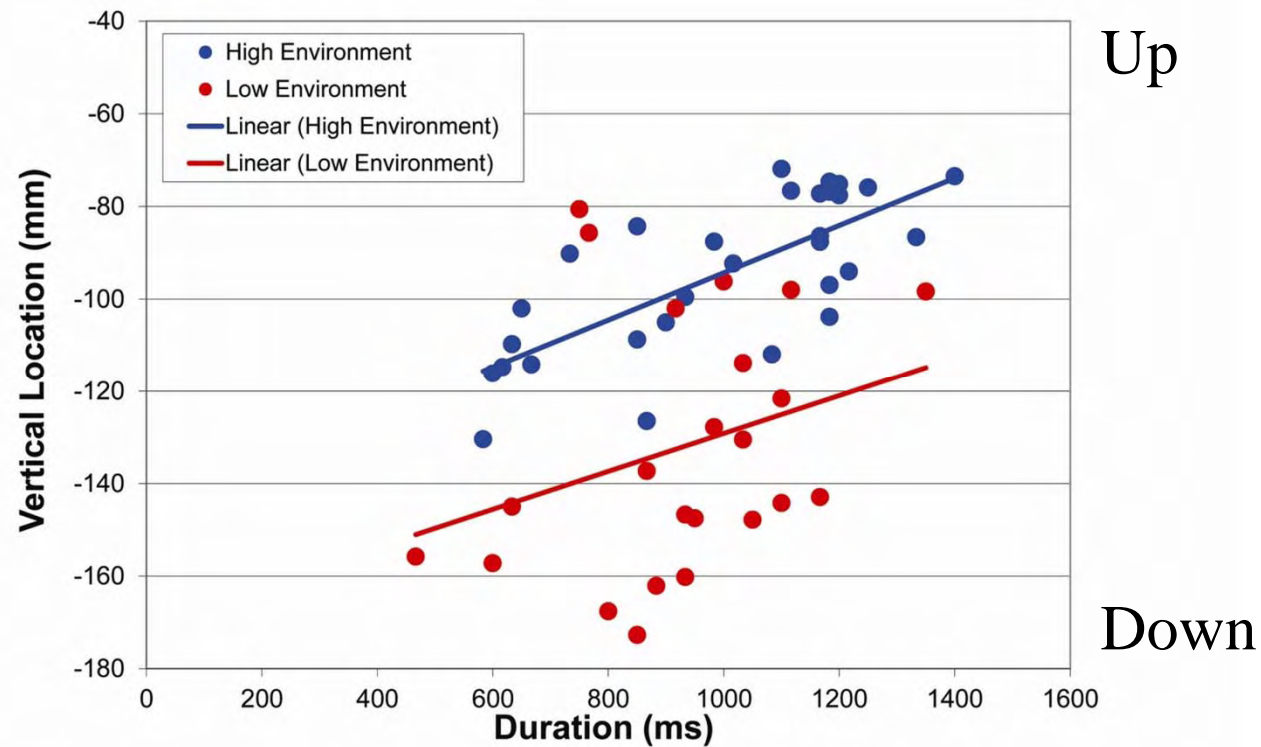
Evaluating Rate Effects

- Location values were compared with duration values to see if significant relationships exist between the two.
 - Separate regressions were generated for each sign in each context on each axis. Data were not pooled across participants.
- Regressions were compared across contexts for each sign via paired t-tests to determine if the difference in phonetic context (high vs. low) was significant.

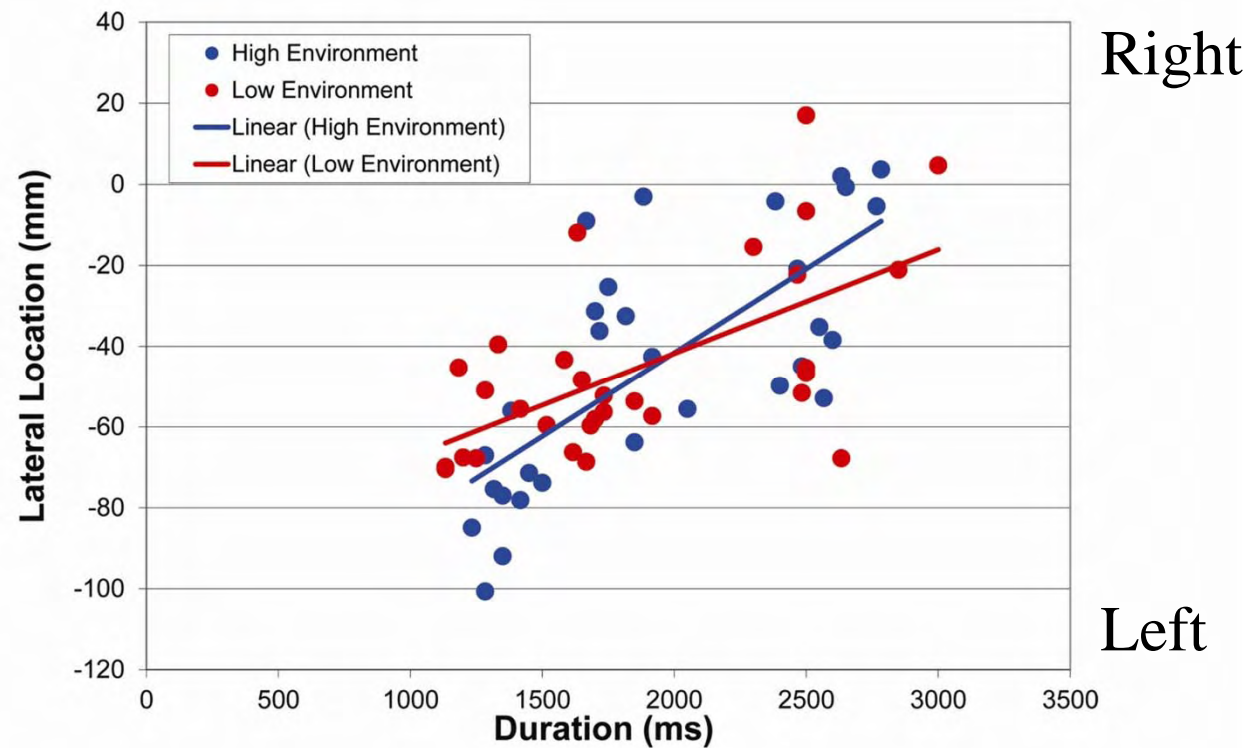
KNOW from Signer VF (Vertical Axis)



KNOW from Signer RD (Vertical Axis)



WHY from Signer MF (Lateral Axis)



Summary of Results

- Rate-dependent variation occurred for all signers, but not for all signs.
 - In the low phonetic environment, the target signs lowered with increased signing speed in 7 out of 15 cases and raised in 2 cases.
 - In the high environment, the target signs raised in 7 out of 15 cases and lowered in 3 cases.
 - Shifts were quite small, usually between 1 and 5 cm.
- Lowering occurred most often for the sign FATHER (4 out of 8 cases), which has not typically been observed to lower.
- KNOW is the sign most often cited as a lowering sign, and it was lowered in 3 out of 8 cases.

Discussion

- Rate was found to have a significant effect on phonetic location for all signers, though shifts were relatively small.
- Where phonetic environment had an effect, it was often as predicted.
- We hadn't expected raising of signs at a high location, but it occurred in a way that was consistent with the phonetic environment.

Discussion

- Lowering from phonetic environment
- Perhaps fast signing leads to a general shift of the entire signing space.
 - Mauk (2003) found raising of neutral space signs in fast signing, even without phonetic environmental pressures.
- Lack of consistency in lowering may be due to a co-occurrence of these two effects.

Directions for Future Research

- Lowering as an effect of sign frequency
- Alternate strategies for achieving body locations (e.g. postural changes of the head and torso)
- Inter- and intra-signer variation in the use of the entire signing space
- Parallel studies of lab data & naturalistic data

Final Thoughts

- This research has uncovered several patterns in sign production, both expected and unexpected.
- These discoveries are only possible because of the development of better methods for data capture.
- Only with more empirical phonetic research can we examine variation across individuals, linguistic contexts, and signed languages.

Acknowledgments

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References

- Battison, R. 1978. *Lexical Borrowing in American Sign Language*. Silver Spring, MD: Linstok.
- Liddell, S., & R. Johnson, 1989. ASL: The phonological base. *Sign Language Studies* 64:195-277.
- Lucas, C., et al. 2002. Location variation in American Sign Language. *Sign Language Studies* 2:407-440.
- Poizner, H., et al. 1987. *What the Hands Reveal about the Brain*. Cambridge, MA: MIT Press.
- Russell, K., et al. 2010. ASL sign lowering as undershoot: A corpus study. *LabPhon* 12.
- Stokoe, W.C. 1960. Sign language structure: An outline of the visual communication systems of the American deaf. *Studies in Linguistics: Occasional Papers* 8. Buffalo, NY: University of Buffalo Press.
- Wilbur, R.B. 1990. An experimental investigation of stressed sign production. *International Journal of Sign Linguistics* 1:41-59.

Target Signs in the Low Environment were...

Sign	Signer	Vertical Axis	Lateral Axis	Sagittal Axis
<i>KNOW</i>	LL	ns	ns	ns
	MF	ns	15 mm to right***	5 mm forward**
	VF	40 mm lower***	42 mm to right***	8 mm forward*
<i>FATHER</i>	LL	23 mm lower***	ns	ns
	MF	10 mm higher*	ns	13 mm forward*
	RD	10 mm higher*	53 mm to left***	ns
	VF	10 mm lower**	ns	ns
<i>WHY</i>	LL	12 mm lower*	ns	10 mm back*
	MF	10 mm lower*	ns	ns
	RD	ns	23 mm to left*	ns
	VF	ns	ns	12 mm back**
<i>STUBBORN</i>	LL	ns	28 mm to left***	5 mm back***
	RD	20 mm lower**	ns	ns
	VF	34 mm lower***	88 mm to right***	ns

*p < 0.05

**p < 0.01

***p < 0.001

Regression Analyses: KNOW

Sign	Environment	Vertical Axis	Lateral Axis	Sagittal Axis
LL	High	-122.8 to -98.1 $\Delta = 24.7$ up***	33.2 to 41.6 $\Delta = 8.4$ right (ns)	120.7 to 118.2 $\Delta = 2.5$ back (ns)
	Low	-117.2 to -143.7 $\Delta = 26.5$ down***	33.1 to 12.7 $\Delta = 20.4$ left***	116.7 to 102.8 $\Delta = 13.9$ back***
	Different?	Yes***	Yes***	Yes*
MF	High	-127.6 to -108.2 $\Delta = 19.4$ up***	48.2 to 41.9 $\Delta = 6.3$ left (ns)	59.3 to 115.1 $\Delta = 55.8$ forward***
	Low	-117.3 to -120.0 $\Delta = 2.3$ down (ns)	75.2 to 20.3 $\Delta = 54.9$ left***	71.0 to 114.8 $\Delta = 43.8$ forward***
	Different?	Yes***	Yes***	Yes*
RD	High	-73.8 to -115.5 $\Delta = 41.7$ down***	-6.7 to -32.1 $\Delta = 25.4$ left **	73.4 to 98.5 $\Delta = 25.1$ forward**
	Low	-114.9 to -151.1 $\Delta = 36.2$ down (ns)	-63.7 to -39.0 $\Delta = 24.7$ right (ns)	59.9 to 81.4 $\Delta = 21.6$ forward*
	Different?	Yes***	Yes***	Yes*
VF	High	-55.6 to -38.5 $\Delta = 17.1$ up*	-45.2 to -50.2 $\Delta = 5.0$ left (ns)	67.3 to 79.7 $\Delta = 12.4$ forward*
	Low	-74.5 to -111.4 $\Delta = 36.9$ down***	0.1 to -49.0 $\Delta = 49.1$ left ***	90.6 to 51.4 $\Delta = 39.2$ back***
	Different?	Yes***	Yes***	Yes*

*p < 0.05

**p < 0.01

***p < 0.001

Regression Analyses: WHY

Signer	Environment	Vertical Axis	Lateral Axis	Sagittal Axis
LL	High	-113.7 to -111.6 $\Delta = 2.2$ up	20.4 to -2.1 $\Delta = 22.5$ left*	142.0 to 124.6 $\Delta = 17.4$ back**
	Low	-123.9 to -133.0 $\Delta = 9.1$ down	14.5 to 2.7 $\Delta = 11.8$ left	134.2 to 110.4 $\Delta = 23.8$ back***
	Different?	NA	No	No
MF	High	-111.3 to -96.6 $\Delta = 14.7$ up**	36.8 to -38.4 $\Delta = 75.2$ left***	123.9 to 118.2 $\Delta = 5.7$ back
	Low	-126.8 to -97.9 $\Delta = 28.9$ up***	30.4 to -27.8 $\Delta = 58.2$ left***	127.6 to 114.3 $\Delta = 13.3$ back*
	Different?	No	No	No
RD	High	-114.9 to -138.3 $\Delta = 23.4$ down	-61.9 to -74.4 $\Delta = 12.5$ left	62.0 to 86.2 $\Delta = 24.2$ forward
	Low	-109.1 to -102.3 $\Delta = 6.8$ up	-83.3 to -87.1 $\Delta = 3.8$ left	43.0 to 161.8 $\Delta = 118.8$ forward***
	Different?	NA	NA	Yes*
VF	High	-80.5 to -99.2 $\Delta = 18.7$ down**	32.1 to -14.7 $\Delta = 46.8$ left***	116.5 to 108.8 $\Delta = 7.7$ back
	Low	-80.5 to -99.2 $\Delta = 18.7$ down**	8.4 to 17.8 $\Delta = 9.4$ right	110.4 to 89.0 $\Delta = 21.4$ back**
	Different?	Yes***	Yes***	Yes***

*p < 0.05

**p < 0.01

***p < 0.001

Regression Analyses: FATHER

Sign	Environment	Vertical Axis	Lateral Axis	Sagittal Axis
LL	High	-88.8 to -131.1 $\Delta = 42.9$ down***	34.4 to 15.1 $\Delta = 19.3$ left	122.9 to 117.0 $\Delta = 6.0$ back
	Low	-107.7 to -102.2 $\Delta = 5.5$ up	29.5 to 30.2 $\Delta = 0.7$ right	130.1 to 116.1 $\Delta = 14.0$ back***
	Different?	Yes***	NA	No
MF	High	-74.5 to -71.6 $\Delta = 2.8$ up	-49.2 to -39.7 $\Delta = 9.5$ right	95.4 to 108.9 $\Delta = 13.5$ forward*
	Low	-53.8 to -79.3 $\Delta = 25.6$ down***	-37.7 to -47.8 $\Delta = 10.1$ left	122.3 to 90.4 $\Delta = 31.9$ back***
	Different?	Yes***	NA	Yes***
RD	High	-64.6 to -52.2 $\Delta = 12.4$ up**	10.8 to -128.9 $\Delta = 139.7$ left***	116.7 to 68.6 $\Delta = 48.1$ back***
	Low	-55.8 to -52.2 $\Delta = 3.6$ up	-18.4 to -134.8 $\Delta = 116.4$ right	131.7 to 53.2 $\Delta = 78.4$ back***
	Different?	No	No	Yes**
VF	High	-7.9 to -22.1 $\Delta = 14.2$ down*	-66.3 to -57.2 $\Delta = 9.1$ right	131.5 to 115.0 $\Delta = 37.5$ back**
	Low	-15.4 to -49.8 $\Delta = 34.4$ down***	-56.7 to -66.8 $\Delta = 10.2$ left	132.6 to 95.0 $\Delta = 37.5$ back***
	Different?	Yes*	NA	Yes*

*p < 0.05

**p < 0.01

***p < 0.001

Regression Analyses: STUBBORN

Signer	Environment	Vertical Axis	Lateral Axis	Sagittal Axis
LL	High	-85.7 to -60.0 $\Delta = 25.6$ up***	72.3 to 45.3 $\Delta = 27.1$ left***	128.2 to 121.4 $\Delta = 6.8$ back***
	Low	-69.2 to -111.7 $\Delta = 42.5$ down***	41.5 to 50.1 $\Delta = 8.6$ right	125.6 to 112.7 $\Delta = 12.9$ back***
	Different?	Yes***	Yes***	Yes*
RD	High	-96.9 to -84.7 $\Delta = 12.2$ up	68.4 to 51.7 $\Delta = 16.7$ left	89.2 to 115.0 $\Delta = 25.8$ forward***
	Low	-106.4 to -87.3 $\Delta = 19.1$ up**	62.5 to 70.3 $\Delta = 7.8$ right	94.0 to 98.4 $\Delta = 4.4$ forward
	Different?	No	NA	Yes*
VF	High	-28.4 to -44.4 $\Delta = 16.1$ down	-28.1 to 3.3 $\Delta = 31.4$ right	130.3 to 147.0 $\Delta = 16.8$ forward*
	Low	-51.1 to -67.9 $\Delta = 16.8$ down**	31.9 to 9.1 $\Delta = 49.1$ left	131.0 to 135.1 $\Delta = 4.1$ forward
	Different?	No	NA	No

*p < 0.05

**p < 0.01

***p < 0.001