Full-day, in home validation of infant body position measurements from inertial sensors

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Abstract

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Full-day, in home validation of infant body position measurements from inertial sensors

Current Study

Methods

Participants

Apparatus

Procedure

Body position annotation

Body position classification

Results

Goal 1: Optimize and validate body position classification model

Goal 2: Assess classification accuracy over long recordings

Goal 3: Examine wear time and compliance in full-day data collection

Goal 4: Determine sensitivity of classification to measure age differences in body position

Discussion

References

Table 1

Summary statistics for model performance metrics shown separately for group and individual models.

Metric	Group			Individual		
	Median	Mean	SD	Median	Mean	SD
Overall Accuracy	0.908	0.848	0.143	0.936	0.919	0.071
Balanced Accuracy	0.909	0.897	0.074	0.916	0.907	0.072
F1	0.813	0.827	0.101	0.873	0.870	0.089
Sensitivity	0.840	0.836	0.123	0.848	0.840	0.121
Pos Pred Value	0.822	0.815	0.125	0.915	0.899	0.108
Kappa	0.769	0.757	0.160	0.846	0.820	0.141

Table 2

Model performance metrics for each body position class, shown separately for group and individual models.

Metric	Position	Group			Individual		
		Median	Mean	SD	Median	Mean	SD
Balanced Accuracy	Supine	0.977	0.935	0.099	0.995	0.957	0.090
	Prone	0.997	0.950	0.110	0.983	0.921	0.132
	Sitting	0.932	0.861	0.151	0.973	0.943	0.071
	Upright	0.930	0.867	0.146	0.937	0.877	0.123
	Held	0.907	0.872	0.111	0.892	0.854	0.153
F1	Supine	0.952	0.873	0.173	0.987	0.937	0.130
	Prone	0.965	0.923	0.124	0.958	0.889	0.186
	Sitting	0.897	0.805	0.247	0.963	0.927	0.101
	Upright	0.781	0.748	0.235	0.868	0.769	0.227
	Held	0.813	0.783	0.163	0.862	0.786	0.240
Sensitivity	Supine	1.000	0.945	0.125	1.000	0.948	0.141
	Prone	1.000	0.907	0.216	0.988	0.856	0.266
	Sitting	0.901	0.787	0.291	0.977	0.917	0.136
	Upright	0.878	0.767	0.275	0.893	0.790	0.255
	Held	0.867	0.774	0.229	0.817	0.722	0.309
Pos Pred Value	Supine	0.973	0.802	0.300	1.000	0.939	0.131
	Prone	0.991	0.896	0.196	0.993	0.901	0.197
	Sitting	0.910	0.840	0.238	0.967	0.947	0.078
	Upright	0.848	0.743	0.285	0.875	0.817	0.205
	Held	0.917	0.803	0.247	0.949	0.872	0.232
Kappa	Supine	0.932	0.770	0.307	0.984	0.913	0.169
	Prone	0.951	0.887	0.208	0.948	0.851	0.242
	Sitting	0.836	0.712	0.308	0.946	0.889	0.134
	Upright	0.729	0.700	0.277	0.829	0.744	0.232
	Held	0.786	0.733	0.219	0.845	0.744	0.280

Table 3

Correlations between human-coded and model-predicted body position durations across the entire long delay period. Correlations are provided within each posture and overall, and computed separately using group and individual models with and without outlier participants.

	With Outliers		Without Outliers	
Position	Group	Individual	Group	Individual
Held	-0.03	0.12	0.55	0.58
Prone	0.97	0.85	0.97	0.84
Sitting	0.73	0.93	0.91	0.97
Supine	0.84	0.94	0.94	0.97
Upright	0.84	0.93	0.99	0.94
Overall	0.80	0.91	0.95	0.96

Table 4

Correlations between human-coded and model-predicted body position durations using 10-minute bins during the long delay period. Correlations are provided within each posture and overall, and computed separately using group and individual models with and without outlier participants.

Position	With Outliers		Without Outliers	
	Group	Individual	Group	Individual
Held	0.45	0.43	0.57	0.55
Prone	0.96	0.89	0.96	0.88
Sitting	0.72	0.92	0.91	0.93
Supine	0.75	0.95	0.90	0.94
Upright	0.93	0.95	0.97	0.95
Overall	0.80	0.94	0.93	0.94

Table 5

Summary of age differences in full-day body position for younger (4- to 7-month) and older (11- to 14-month) infants. Values shown are the mean percent of time for each body position averaged across infants in each group. Standard deviations are shown in parentheses. Descriptive statistics are shown separately for group and individual models.

Position	Group		Individual	
	Younger	Older	Younger	Older
Upright	7.6% (8.9)	18.6% (7.4)	9.9% (13.1)	18.7% (8.4)
Sitting	26.3% (12.1)	44.4% (10.1)	20.2% (16.3)	46.9% (13.3)
Prone	13.8% (13.5)	14.4% (6.0)	11.9% (9.9)	16.9% (10.6)
Supine	37.9% (23.2)	14.0% (8.4)	39.4% (30.3)	10.0% (9.5)
Held	12.7% (6.9)	8.5% (5.4)	17.6% (19.9)	7.4% (7.6)
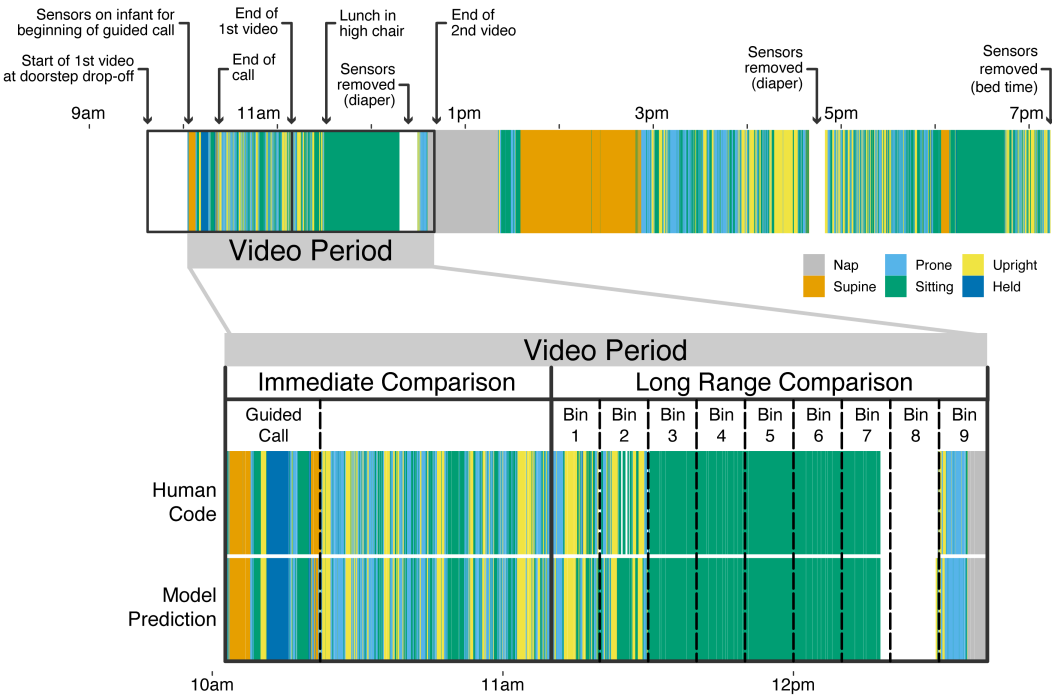
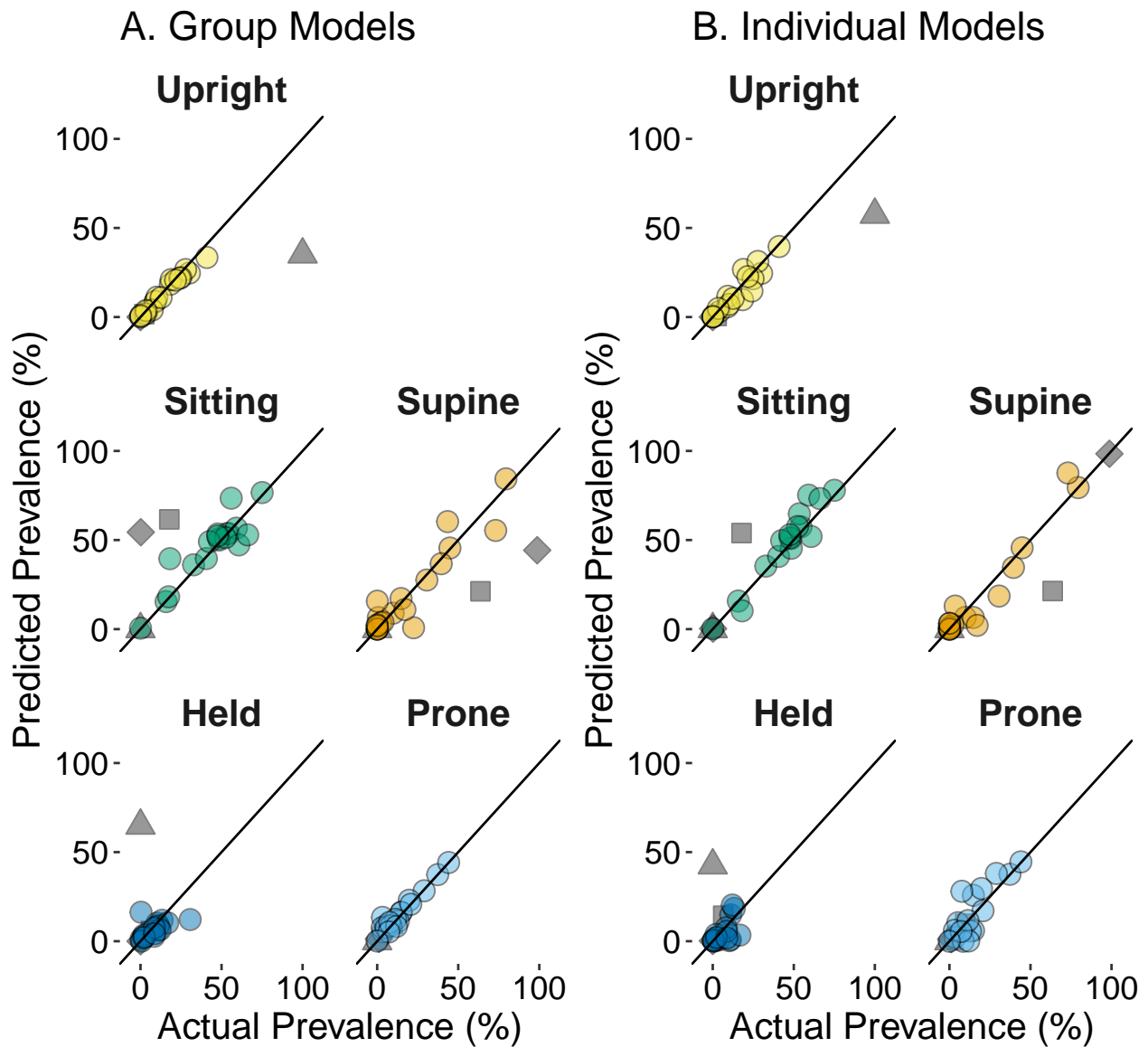*Figure 1*. Example Timeline Caption.
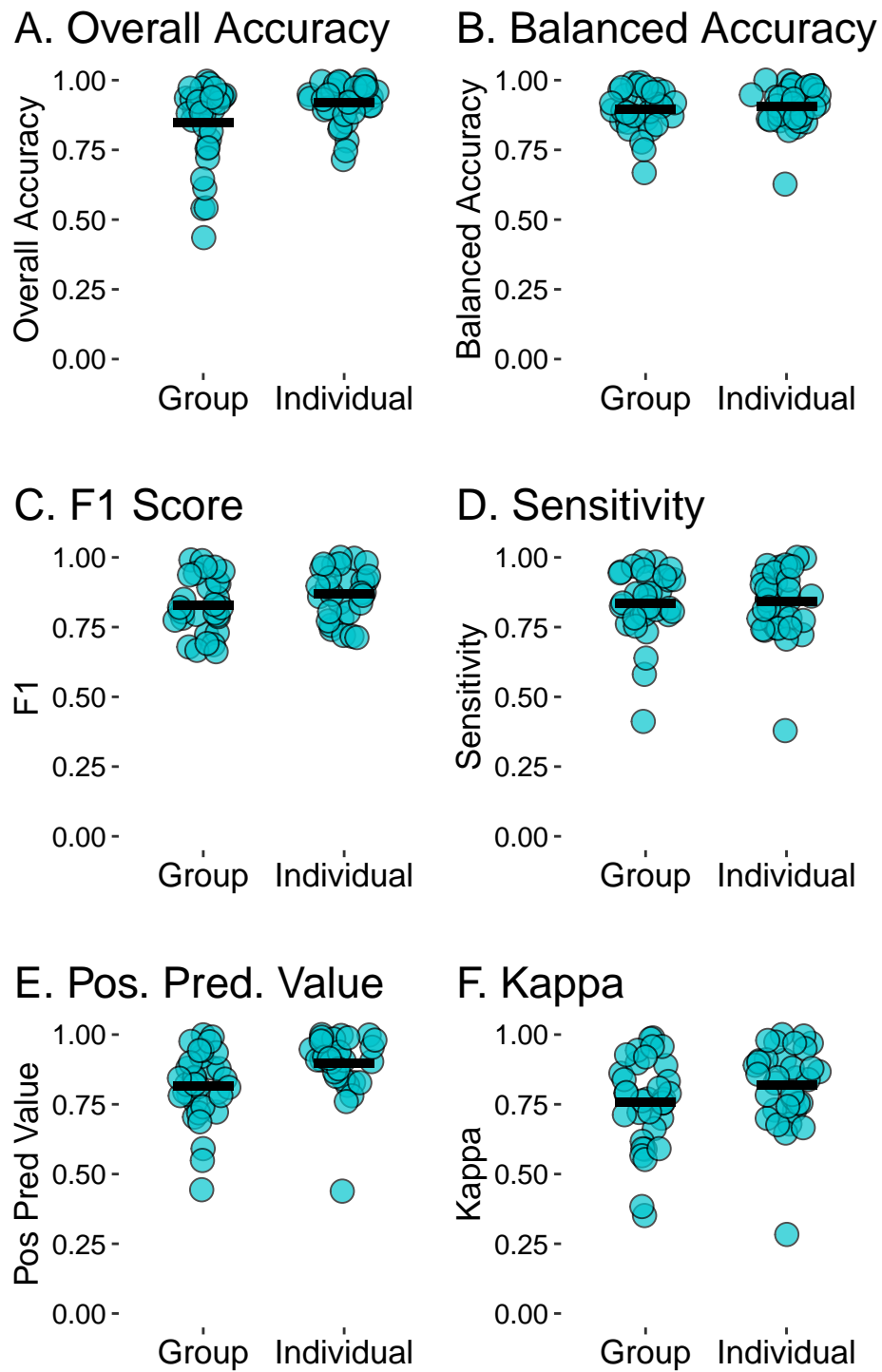
Figure 2. Metrics

Figure 3. Overall agreement between human-coded body position and model-predicted body position in the long-delay period. Agreement for group models is shown in (A) and agreement for individual models is shown in (B). Plots are shown separately for each body position with a reference line that indicates perfect agreement; each point in a plot represent data for a single participant. The three outlier participants are plotted in dark gray, with a different shape marking each individual.
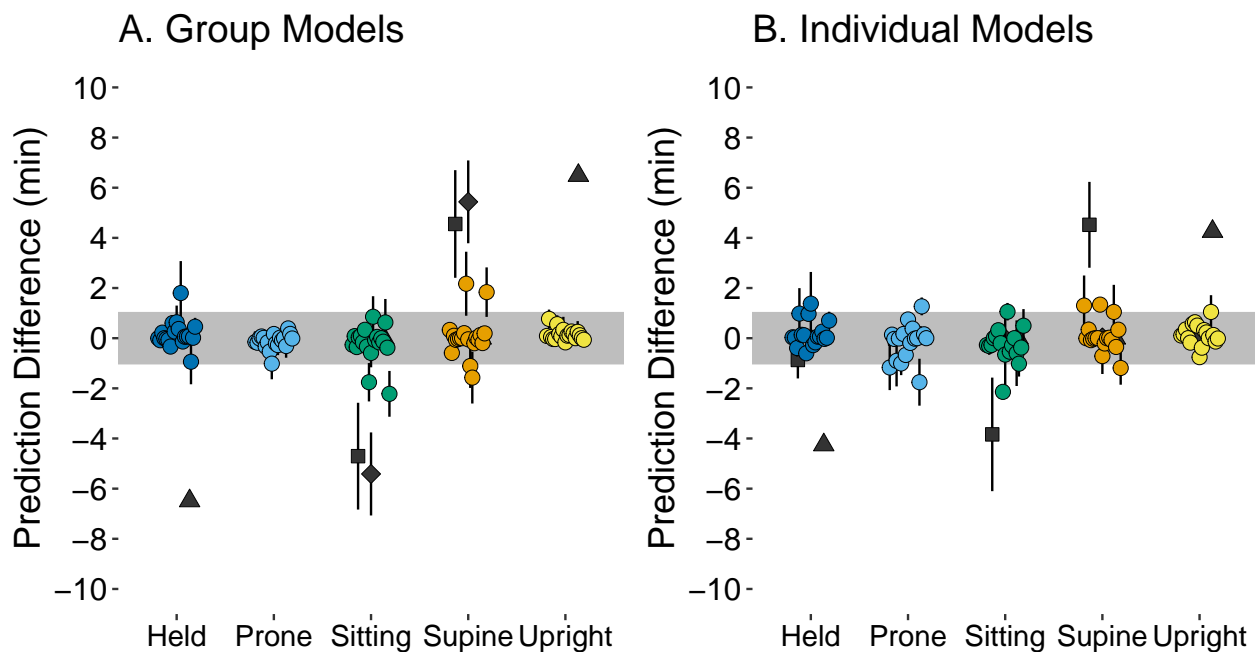
Figure 4. Prediction performance (difference in minutes between human-coded and model-predicted body position) for 10-minute bins in the long delay period. Each point shows the mean and SE for a single participant for each body position, summarizing the prediction difference for each of their 10-minute bins. Points falling within the gray shaded region indicate that average prediction errors were less than 1 minute. Performance is plotted separately for (A) group models and (B) individual models. The three outlier participants are plotted in dark gray, with a different shape marking each individual.
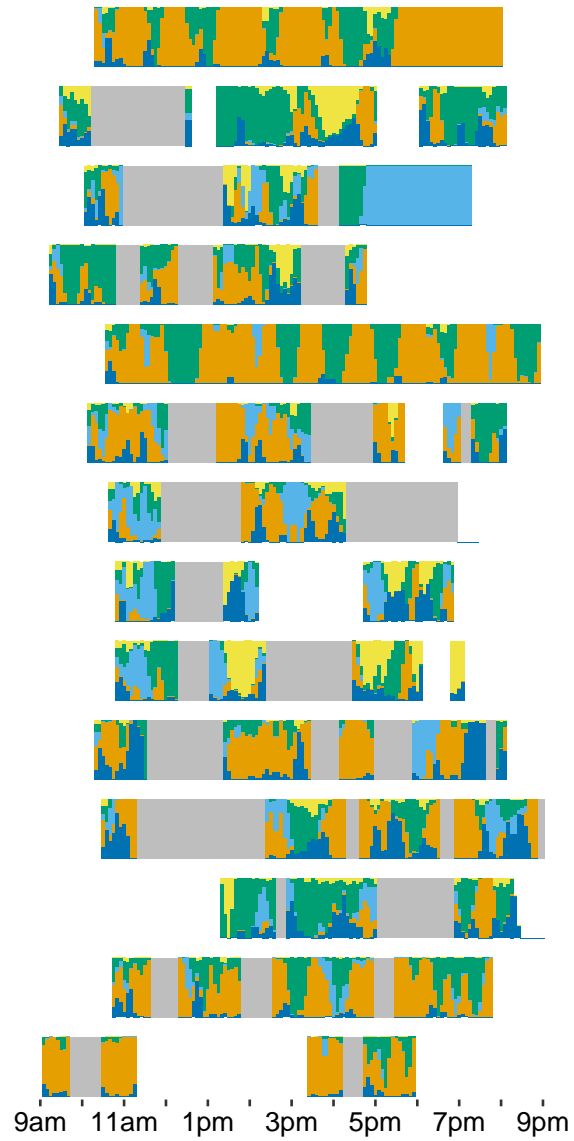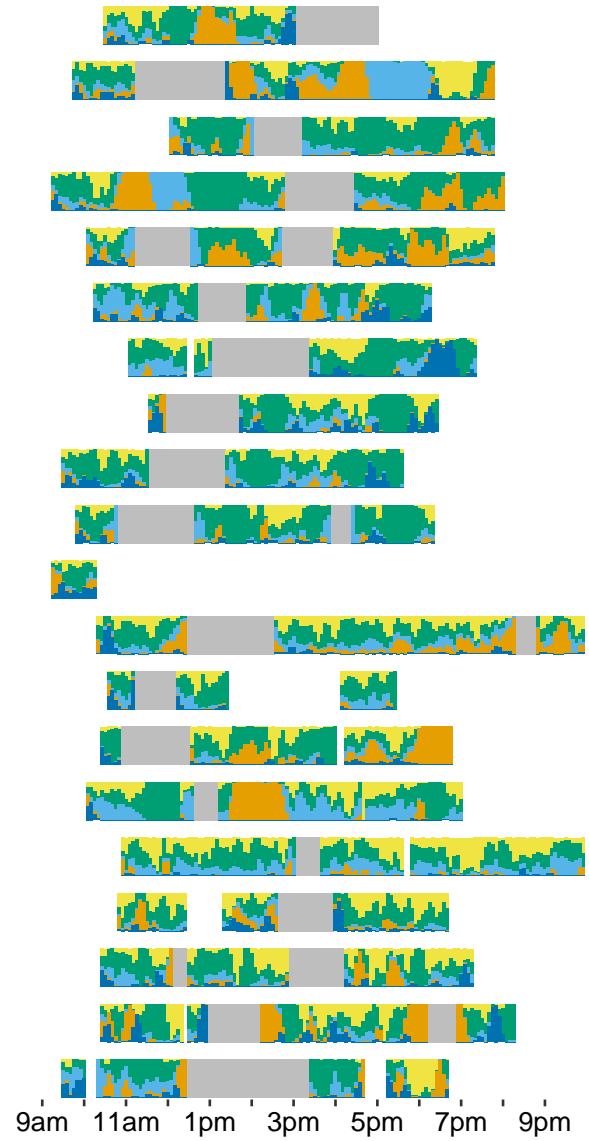
Figure 5. Timelines

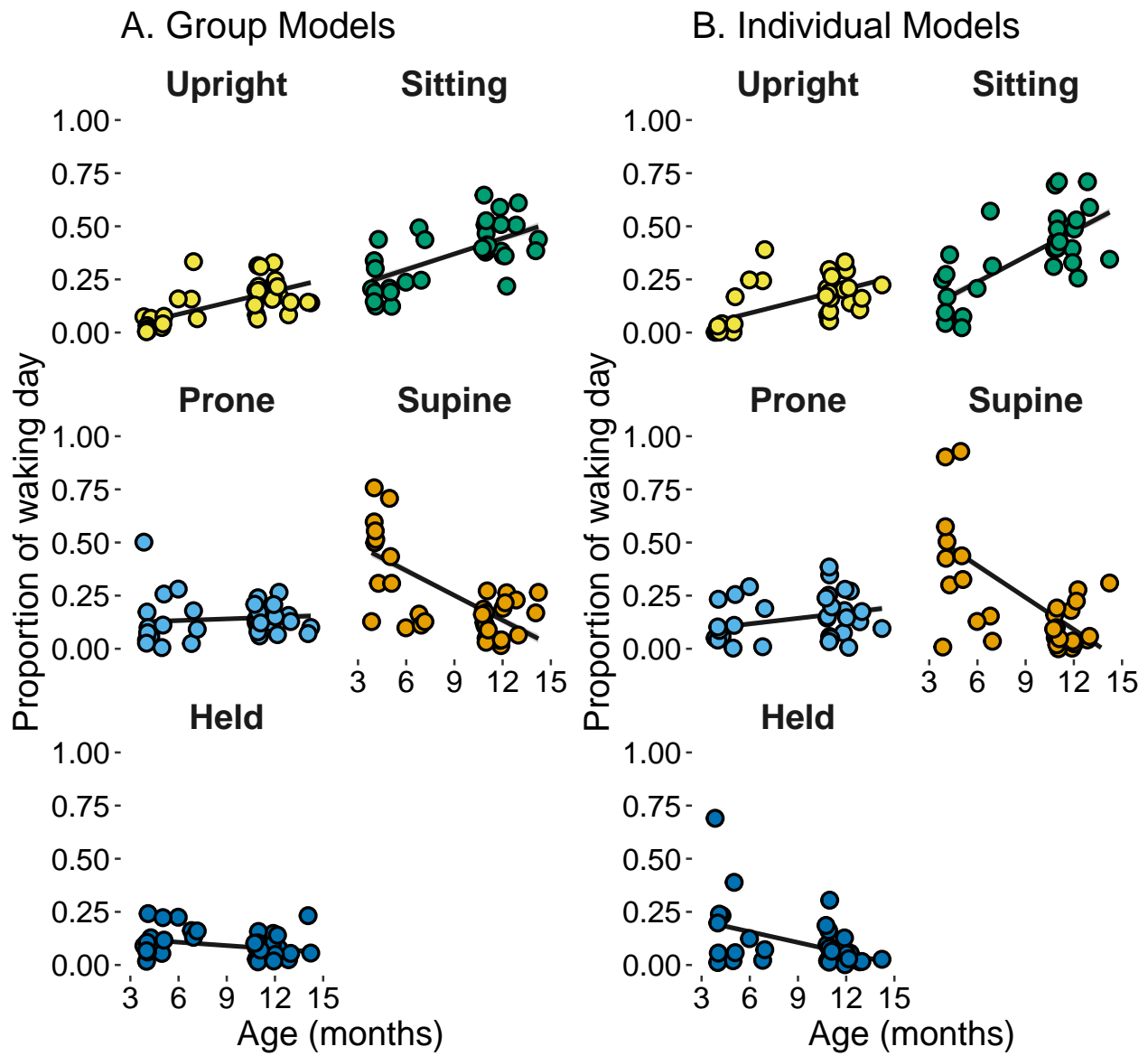*Figure 6*. Age trends