What do we see in each other: How movement drives social interaction

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Introduction

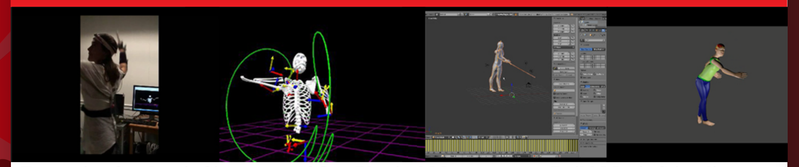
The movements of every individual carry unique stochastic signatures of movement variability that *could* serve as a motion 'finger print' (Torres et al., 2011).

We sense movement both visually and kinesthetically
- o Do these modalities align to form a congruent percept?
- o Do we interact with others based on how similar or different their movements are from our own?

Perceiving motion is crucial for social interactions (Shiffrar, 2011)
- o **New question: are the temporal dynamics of our perceptual processes aligned to that of our actual physical movements?**

This pilot study developed in an **IGERT class** by the students explores this question

Methods

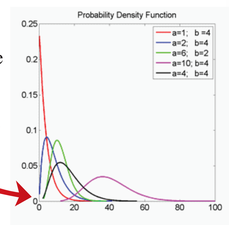


Extracting Stochastic Signatures of Our Physical Movements to Build Movie Stimuli:
- o 16 Polhemus electromagnetic sensors, 240 hz
- o 2 sports routines (martial arts, tennis serve), 2 experts and 4 novices
- o Variable sensory input (fast/slow, dark, mirror, etc.)

Motion Playback:
- o Build avatar endowed with different noise signatures
  - No noise (veridical motions)
  - Noise from each subject
  - 2 levels of noise from the Gaussian and from the Exponential distributions that we have found in individuals with a compromised system (Parkinson's, ASD)
- o All avatars were identical in appearance
  - Subjects made stimuli with random exposure to variants of others and their own noise

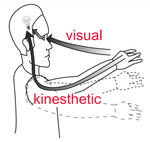
Visual Recognition of our Stochastic Signatures of Movement:
- o Visual decision making by pointing
  - 180 trials (4 blocks x 45 trials)
- o Martial arts group tested on martial arts videos
- o Tennis serve group tested on tennis serve videos

Parameters of Interest
- o Movement decision time (ms) time from appearance of response boxes to time of touch
- o Decision accuracy (% correct)
- o Distributional analysis of the temporal dynamics of the physical motions to determine the stochastic signatures
  - maximum likelihood estimation of the **gamma** parameters (a,b) with 95% confidence
  - The **gamma family** spans the range of noise that occurs in the continuum of human movement
- o Physical motions of the decision-making process, kinematics from hand movement trajectories of the pointing process



$$y = f(x \mid a,b) = \frac{1}{b^a \Gamma(a)} x^{a-1} e^{-\frac{x}{b}} \quad (1)$$

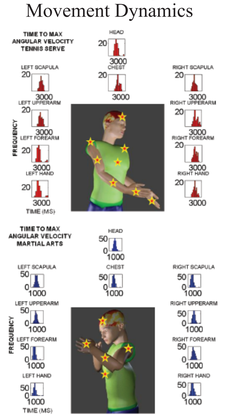
Results

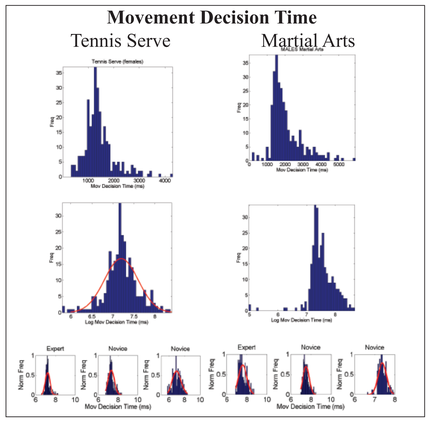


Movement Perception

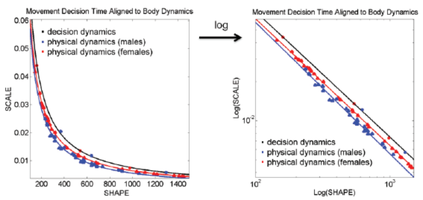
- o Distributions of the time to peak angular velocity from the body's joints are ***skewed***, and well fit by the gamma-family
- o Movement decision time during the decision making experiment is also skewed and well-fit by the gamma
- o we plotted the maximum likelihood estimate on the gamma plane
  - the log-transform of that data

Variability of Physical Movement Dynamics





- o log-transform of the maximum likelihood estimate data (time to peak angular velocity (ms) and movement decision time(ms) well-fit by the gamma family
  - plotted on the gamma plane on a log/log scale
  - we found a power fit



Power Model $f(x) = a^*x^b$ Coefficients (with 95% confidence bounds) and error:	Time to Peak Angular V Tennis Serve (ms)	Time to Peak Angular V Boxing Martial Arts (ms)	Movement Decision Time (ms)
	a = 5.755 (4.995, 6.515) b = -0.9999 (-1.022, -0.9772) Goodness of fit: R-square: 0.9983 RMSE: 0.0002638	a = 5.476 (4.915, 6.037) b = -0.9771 (-0.9957, -0.9584) Goodness of fit: R-square: 0.9987 RMSE: 0.000401	a = 5.966 (5.07, 6.862) b = -0.9677 (-0.9957, -0.9396) Goodness of fit: R-square: 0.9998 RMSE: 0.0002362

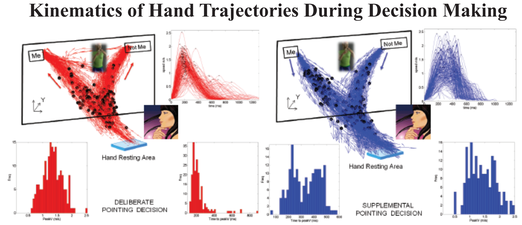
Friedman's Test - Decision Time (ms)

Friedman's Test Subject Type Effect of Noise of others for each individual own noise	Chi-square	P value
G1	6	0.0143
G2	0.1667	0.6831
G3	6	0.0144
B1	17.0213	3.6963e-005
B2	5.0417	0.0247
B3	18.3750	1.8142e-005
Population Comparison of noise on affect across colorings	135.5	1.5897e-027
Noise of others vs. autistic like noise for all	172.4	7.6418e-034

Decision Accuracy (% Correct)

	Veridical	Self Noise	Noise of Others	ASD Noise	Overall Accuracy
G1	100%	75%	73%	75%	86%
G2	100%	100%	100%	100%	99%
G3	50%	35%	27%	25%	51%
B1	100%	85%	75%	75%	87%
B2	100%	60%	63%	43%	58%
B3	50%	75%	71%	71%	73%

Kinematics of Hand Trajectories During Decision Making



- o Martial Arts group was more confident
- o Tennis Serve group was more accurate

Discussion

- o We found alignment between the rhythm of our decision making processes and that of our physical movements
- o The decision-making process may continue even after indicating the decision
  - Uncertainty (noise) due to the still-unfolding decision making process reflected in the pointing movements
- o Subjects deciding on the tennis serve had more uncertainty (took more time) but higher accuracy
- o Martial arts participants were more certain but had lower accuracy
- o These groups happen to be of different genders
  - o Could there be sex differences on this task? Or do the differences lie in the routine type?

Future Directions

- o Increase our sample size
- o Expand the task
  - Judge the movements of others as well as the self
  - Not limited to choice of me or not me (egocentric)
- o Expand to ASD populations
  - Understand social cognition in these populations from the sensory-motor perspective
- o Expand to test on other experts otherwise unfamiliar with the stimuli
- o This study was done as part of a **Graduate-level IGERT class in Perceptual Science**
  - Interdisciplinary course designed to foster collaboration
  - Expand to the Undergraduate level in light of the impact it had at the Graduate level

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