Knowledge of Uncertainty in Physical Prediction

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Introduction

- Physical prediction is well explained as accurate extrapolation of an uncertain, probabilistic world (Battaglia et al. 2013, Smith & Vul 2013)
- Implies that people form a probability distribution over possible future states
- Can people reason about the uncertainty captured in these probability distributions?

Task

<table>
<thead>
<tr>
<th>Observe initial motion</th>
<th>Predict motion &amp; set paddle length</th>
<th>Observe actual path</th>
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</thead>
<tbody>
<tr>
<td></td>
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<td>N = 43</td>
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<tr>
<td></td>
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<td>450 trials / participant</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Measures:</td>
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<tr>
<td></td>
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<td>1. Predictions</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(paddle position)</td>
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<tr>
<td></td>
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<td>2. Uncertainty</td>
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<tr>
<td></td>
<td></td>
<td>(paddle length)</td>
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</tbody>
</table>

Prediction model

Physical forward model + Center expectation

- Explains predictions
- Explains variability

Smith & Vul (2013)

Results

1) By-trial uncertainty relates to variability in predictions

- \( r = 0.45 \)

2) Model explains by-trial uncertainty well

- \( r = 0.45 \)

3) Uncertainty explained in part by both measures

- Across Subj SD: \( r = 0.51 \), \( r_{part} = 0.38 \)
- Model SD: \( r = 0.45 \), \( r_{part} = 0.28 \)
- Paddle Length: \( r = 0.45 \), \( r_{part} = 0.29 \)

All ps \( << 0.001 \)

Discussion

- Explicit measures of uncertainty track estimates of how much uncertainty people should have
- Suggests that people have and use probabilistic distributions over where objects might go
- Both estimates of uncertainty capture different facets of peoples’ uncertainty

References
