Mutimodal Cueing to Facilitate Spatial Understanding for Virtual Environment Tasks

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Introduction

- Human information processing is fundamentally limited, but information can be adapted to mitigate the effect of that limitation. One approach is to utilize multiple modalities in the information display rather than overloading a single modality. The extent to which this adaptation can work depends on the nature of the information and the fundamental characteristics of the human information processing system.
- In this project, we are interested in how people combine multimodal information when leveraging spatialized auditory input for spatial awareness, considering cognitive thresholds.
- Wenzel, Godfroy-Cooper, and Miller (2014) showed that RT benefits from bimodal display cues, but it is unclear whether this is the result of a cognitive advantage or if it is simply statistical facilitation due to redundancy gain.
- This project seeks to replicate and expand on previous work using workload capacity and assessment function analyses to examine possible RT/accuracy advantages assuming a UCIP model.

Experimental Design

- Inspired by Wenzel, Godfroy-Cooper, and Miller (2014) with modifications for military interests
- 48 participants (12 in each Environmental Condition: 6 completing lateralization tasks & 6 completing localization tasks)
- Each target associated with name, icon on small visual map, & earcon in 3d spatial audio
- Training: 15 practice trials (5 trials/modality, 3 tasks/trial)
- Experiment: 30 trials (10 trials/modality, 3 tasks/trial)
- Presentation order randomized within and across modalities

Results/Conclusions

<table>
<thead>
<tr>
<th>Environmental Conditions</th>
<th>Ambiguity</th>
<th>Earcons</th>
</tr>
</thead>
<tbody>
<tr>
<td>High: All targets appear as jeeps in environment</td>
<td>Low: Targets appear as Habitat, Lara, Tank, Bob, &amp; Jeep</td>
<td>Habitat – water fountain</td>
</tr>
</tbody>
</table>

Visibility

- High: No sand storm
- Low: Sand storm

Visibility

- High: All targets appear as jeeps in environment
- Low: Targets appear as Habitat, Lara, Tank, Bob, & Jeep

Ex-Gaussian RT Analysis³

- Ex-Gaussian (mu, sigma, tau)
- Exponential Component (tau)
- Gaussian Component (mu, sigma)

Workload Capacity¹

- Lateralization Task
- Localization Task

Assessment Functions¹

- Lateralization Task
- Localization Task

Table: Results/Conclusions

<table>
<thead>
<tr>
<th>Condition</th>
<th>Lateralization</th>
<th>Localization</th>
</tr>
</thead>
<tbody>
<tr>
<td>Auditory</td>
<td>943 623 2057</td>
<td>2271 1838 3440</td>
</tr>
<tr>
<td>Visual</td>
<td>914 981 1721</td>
<td>2672 136 2696</td>
</tr>
<tr>
<td>Bimodal</td>
<td>1091 736 1698</td>
<td>2350 1290 3068</td>
</tr>
</tbody>
</table>

References


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