

Introduction

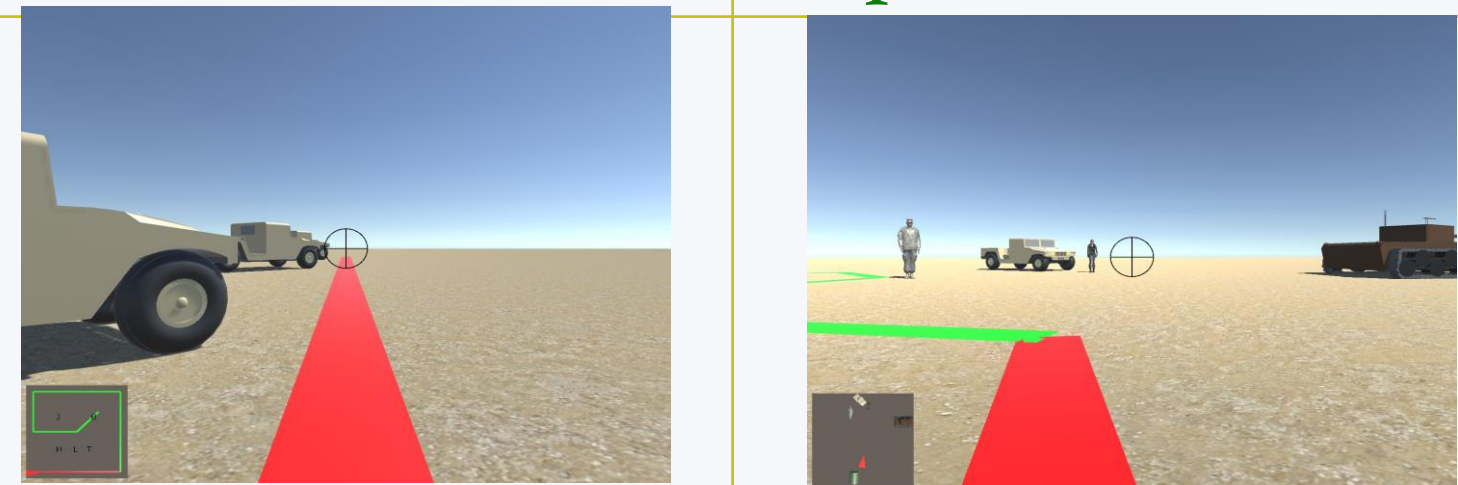

- Human information processing is fundamentally limited, but information can be adapted to mitigate the effect of that limitation. One approach is to utilize multiple modalities in the information display rather than overloading a single modality. The extent to which this adaptation can work depends 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)³ 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)³ 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

Environmental Conditions

Ambiguity

	High: All targets appear as jeeps in environment	Low: Targets appear as Habitat, Lara, Tank, Bob, & Jeep
Visibility	High: No sand storm	
	Low: Sand storm	

Earcons

- Habitat – water fountain
- Lara – footsteps on metal stairway
- Tank – old fashioned treadle machine
- Bob – footsteps crunching on leaves
- Jeep – engine revving and idling

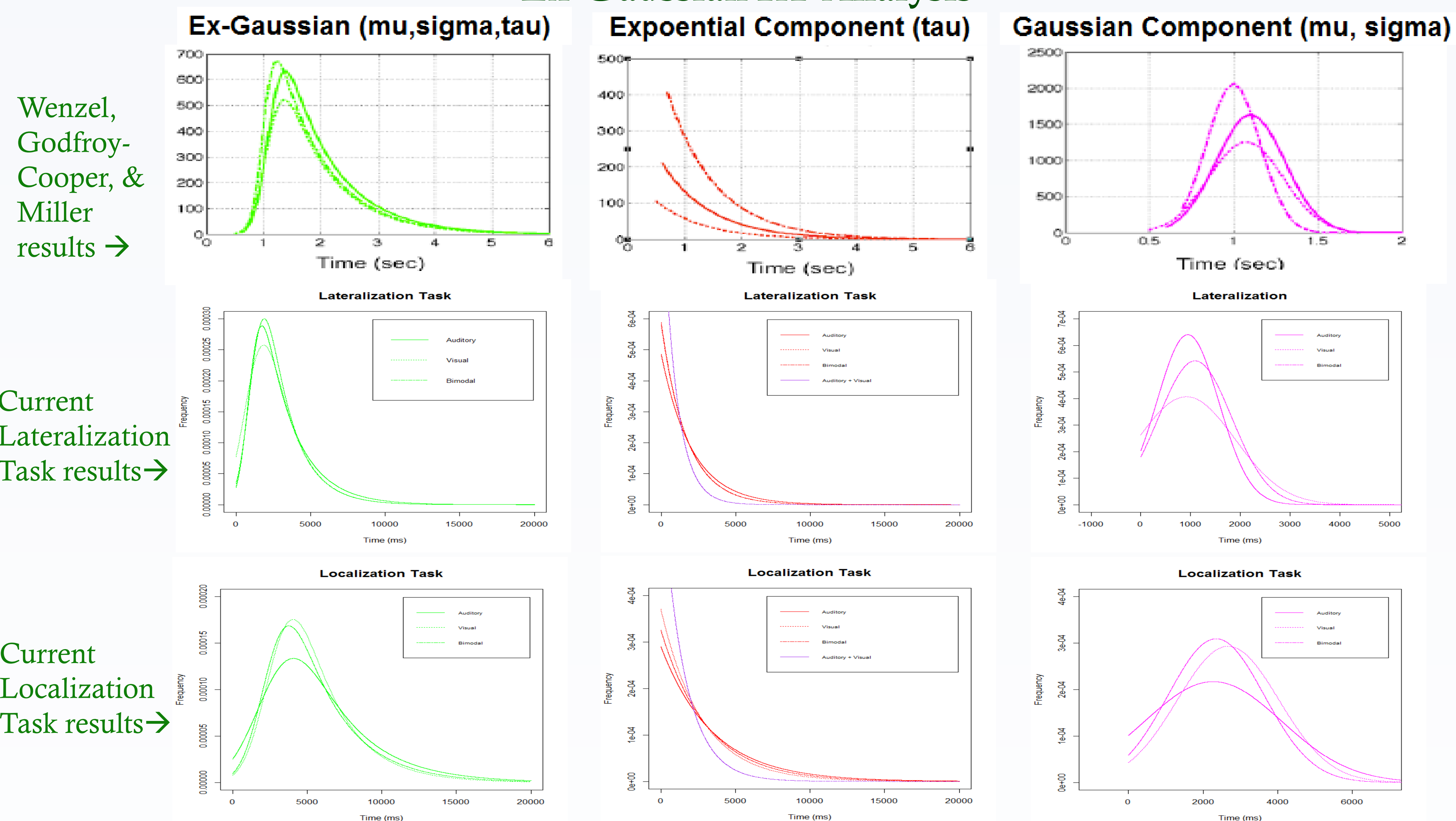
Lateralization Task



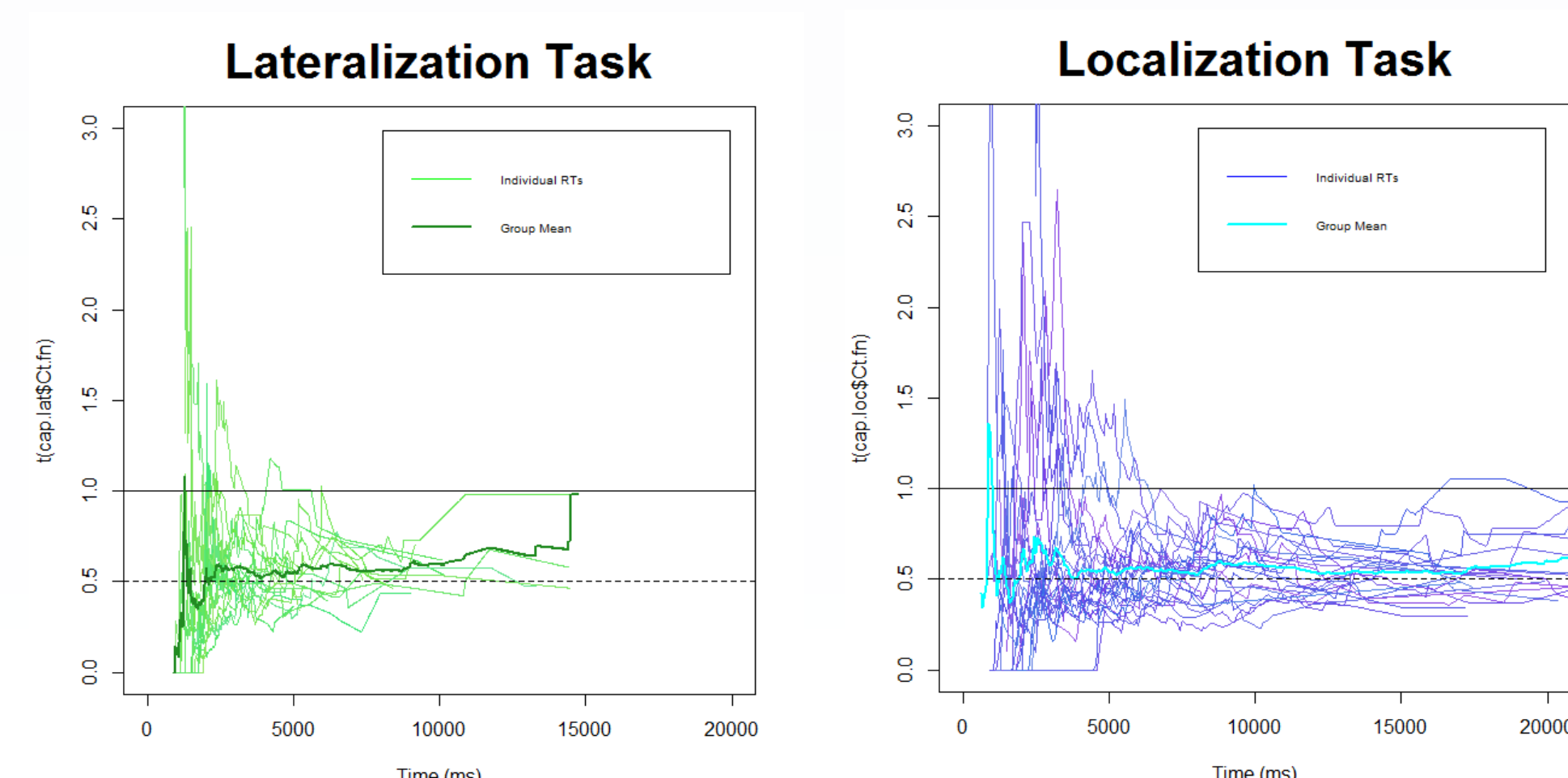
Localization Task



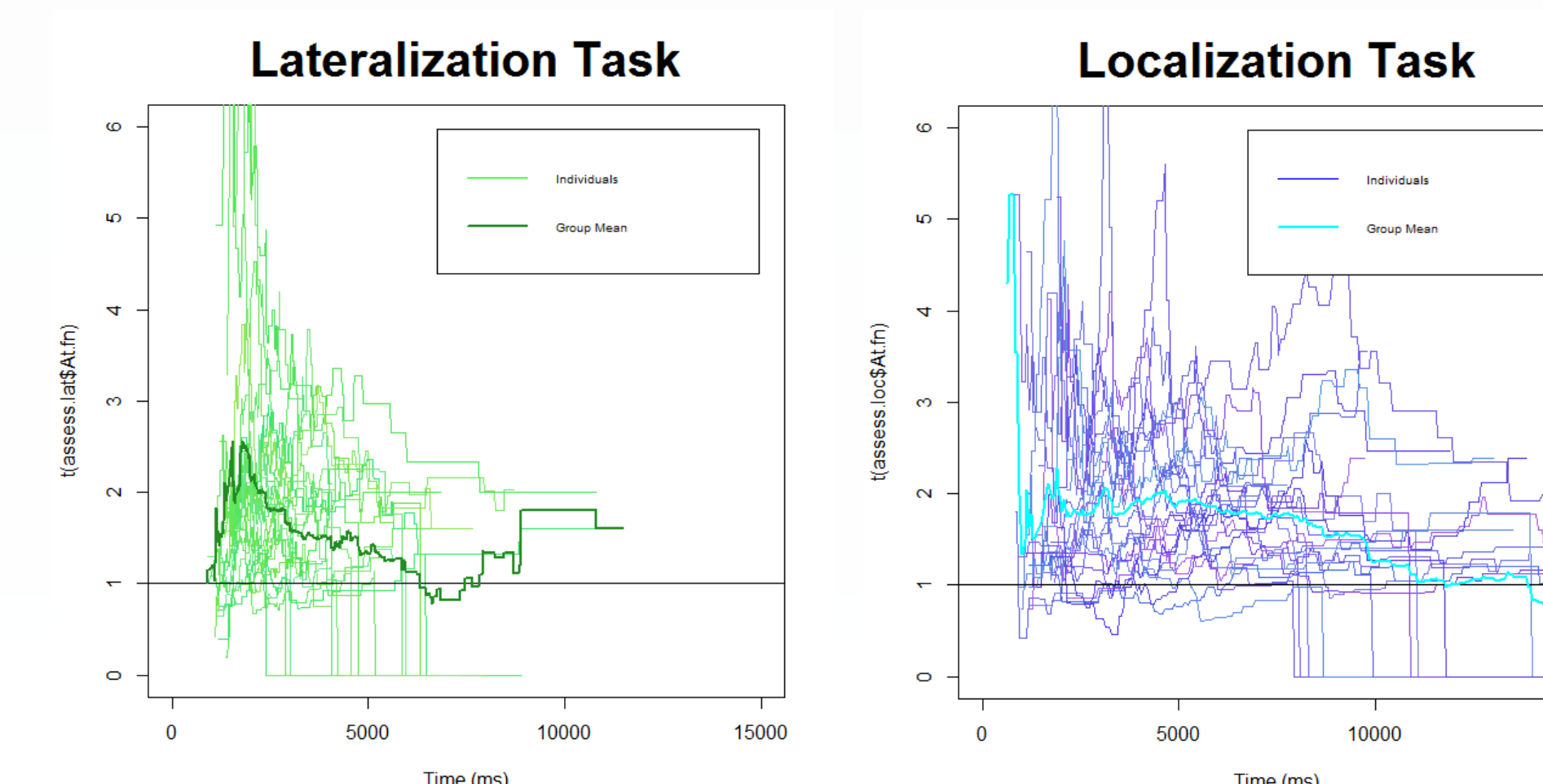
Ex-Gaussian RT Analysis³



Workload Capacity¹



Assessment Functions¹



Results/ Conclusions

	Lateralization			Localization		
	mu	sigma	tau	mu	sigma	tau
Auditory	943	623	2057	2271	1838	3440
Visual	914	981	1721	2672	1361	2696
Bimodal	1091	736	1698	2350	1290	3068

- The ex-Gaussian RT analysis shows that the parameters (mu, sigma, and tau) behave differentially as a function of modality.
- Previous work showed clear facilitation among response times. We do not find response time facilitation in the results of current study, hence our RT data shows limited capacity processing.
- However, the use of the assessment function revealed performance equal to or better than standard parallel processing, showing a clear RT/accuracy advantage.
- Like previous work, extent of advantage of bimodal display cues varies across conditions, which may mean the value of multimodal cueing depends on the navigation environment.

References

- Houpt, J. W., Blaha, L. M., McIntire, J. P., Havig, P.R., & Townsend, J. T. (2014). Systems factorial technology with R. Behavior Research Methods, 46, 307-330.
- Houpt, J. W., & Townsend, J. T. (2012). Statistical measures for workload capacity analysis. Journal of Mathematical Psychology, 56, 341-355.
- Wenzel, E. M., Godfroy-Cooper, M., & Miller, J. D. (2014, June). Spatial auditory displays: Substitution and complementarity to visual displays. Paper presented at International Conference on Auditory Display, New York, USA.

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