

How Social Context Shapes Neural Function: Operationalizing Social Influences with Biomarker Integration in TBI Evaluation

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Background

- Traumatic brain injury (TBI) is caused by a rapid blow, jolt, or pressure wave to the head; risks include early death, rehospitalization, and increased suicidality.
- TBI has long been seen as a static condition, but understanding has shifted toward viewing it as a chronic, dynamic injury.
- Recent frameworks, like the CBI-M (Clinical, Biomarker, Imaging + **Modifier**), and NASEM's *TBI Roadmap for Accelerating Progress*, push integrative models (e.g., biopsychosocial-ecological [BPSE]) to comprehensively evaluate recovery.
- Yet, outcomes remain variable and **systematic measurement and integration of the social dimension is underdeveloped.**

Social Networks & TBI

- **Social networks:** People connected to you who shape support and everyday experience.
- Social networks are linked with improved recovery, mortality, functional outcomes.
- Post-TBI, social networks tend to atrophy.
- Social network science and methods are rarely incorporated in TBI research: almost never linked with Imaging (i.e., electroencephalography [EEG]) or operationalized in clinically actionable ways.
- In neuroplastic error-driven learning, social networks are a "cognitive ecology," shaping cultural models (e.g., meaning, learning priors) and influencing access to resources (Fig 1).

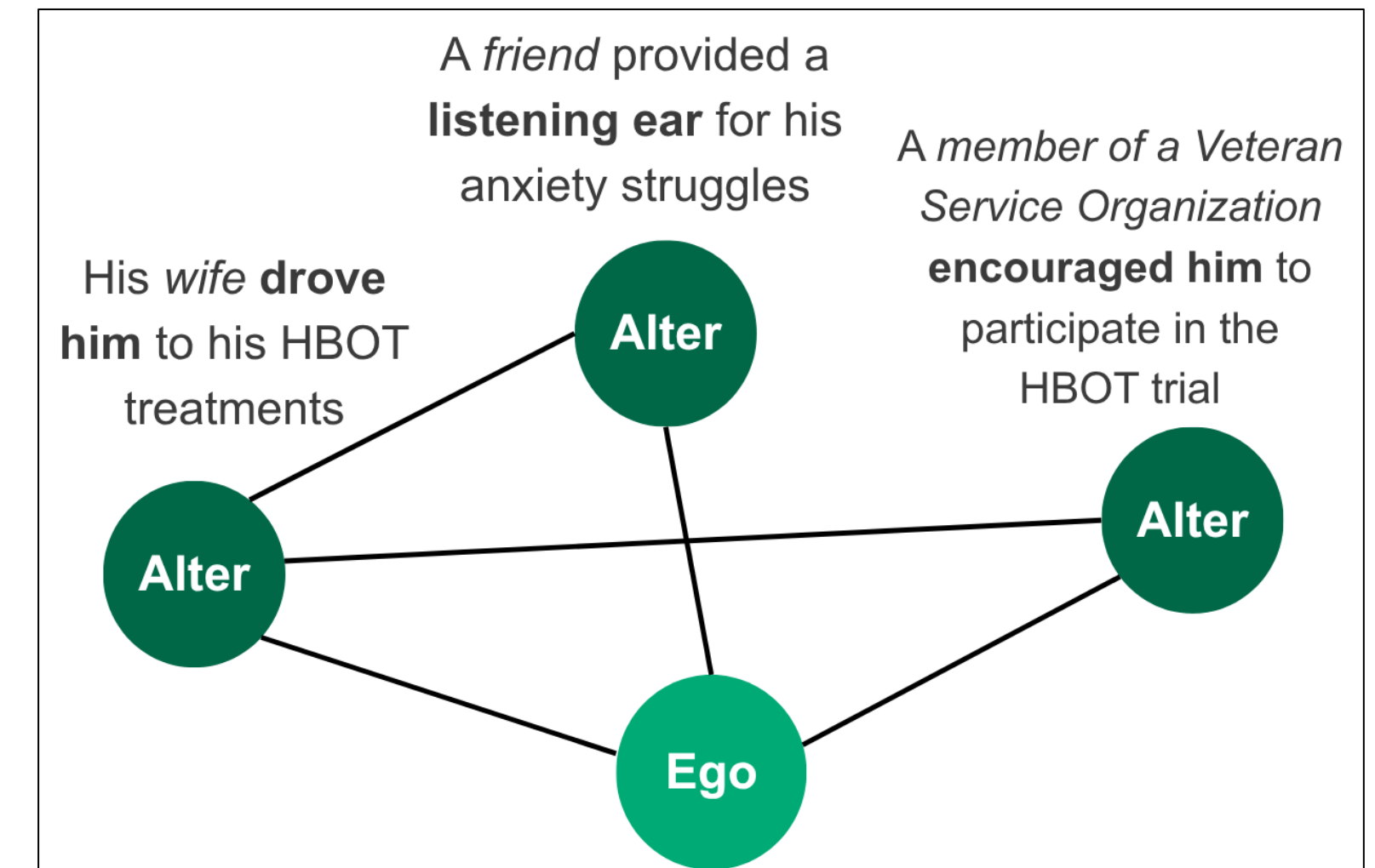


Figure 1. Resource flows in social networks.

Methods

- Medical anthropology study in a hyperbaric oxygen therapy (HBOT) clinical trial with Service Members/Veterans with TBI.
- Preliminary sample: 13 at baseline (target n=200 + 4 waves).
- Interviews with personal network inventory and Mayo-Portland Inventory-4 items, with variables of network size, Service Member homophily, social contact difficulty (**Table 1**).
- EEG used a 16-image picture-naming task (**Fig 2**).
- Event-Related Potential (ERP) waveforms (observed vs. expected) analyzed post-stimulus to identify candidate relationships between social variables and timing of neural responses during task performance.

Table 1. Social Network Interview Items

Variable	Interview Item
Size	"Over the last 6 months, who are the people with whom you discussed important personal matters?"
Homophily	"Is this person a Veteran/Service Member?"
Social Contact Difficulty	"How involved are you in social contact with friends, coworkers, other people who are not family, significant others, or professionals? How difficult is it to interact?"



Figure 2. Example Picture-Naming Task Stimuli

Preliminary Findings

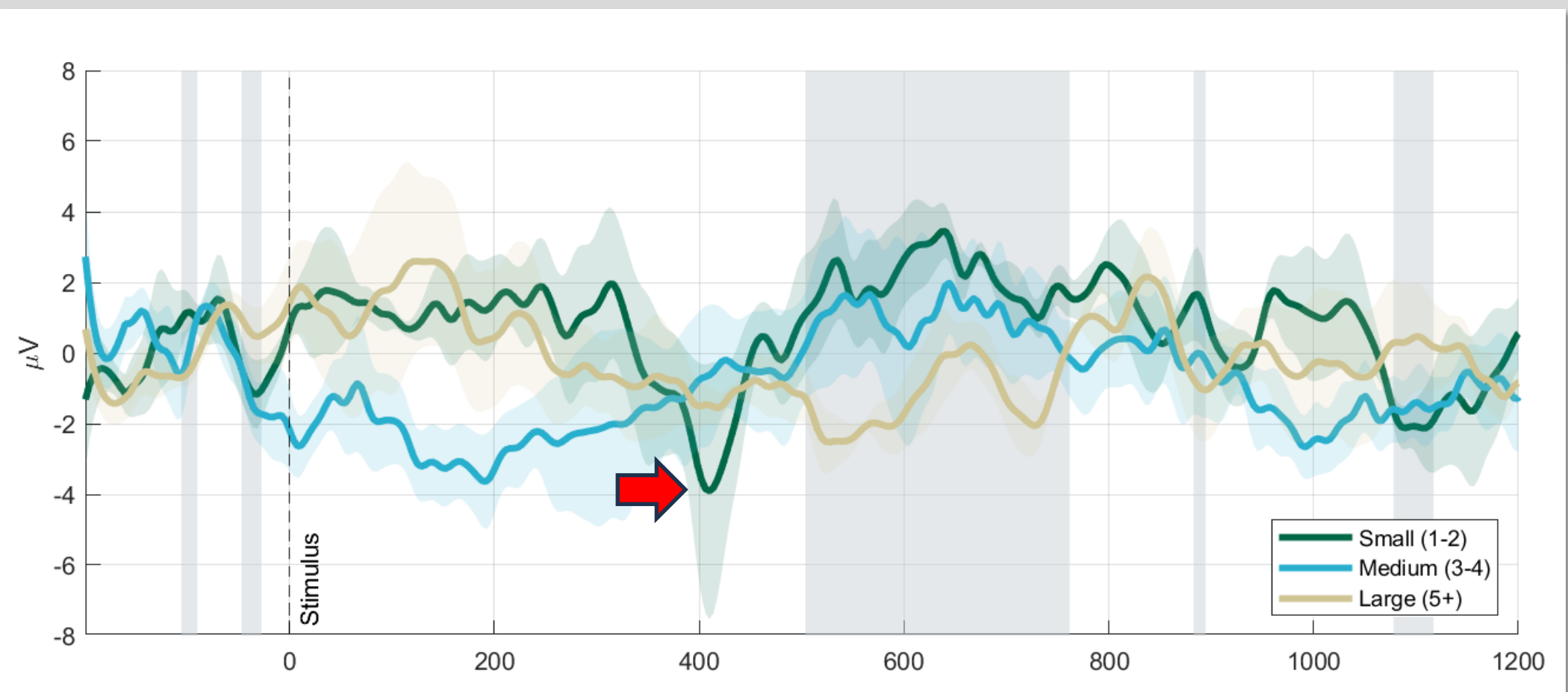


Figure 3. Preliminary Results: Network Size ($d = 0.5$)

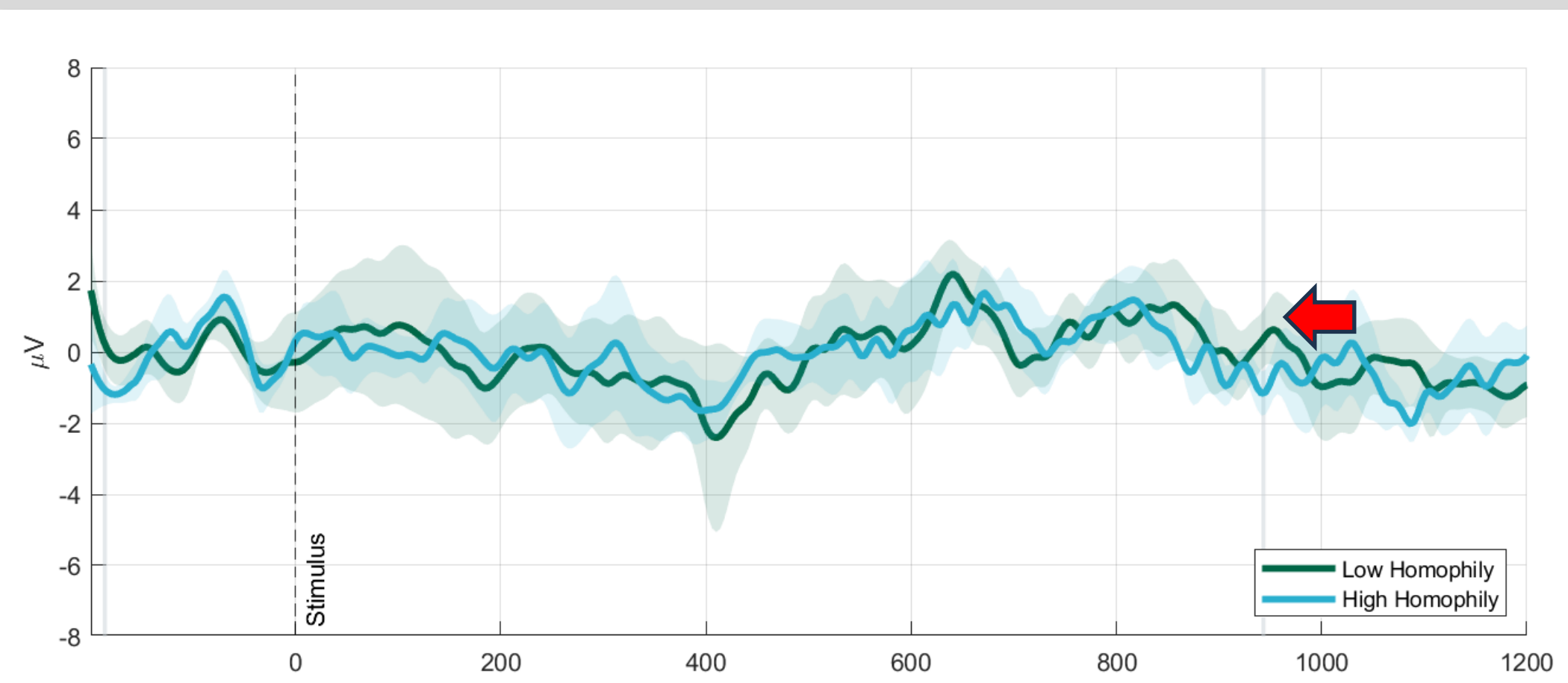


Figure 4. Preliminary Results: Homophily ($d = 0.8$)

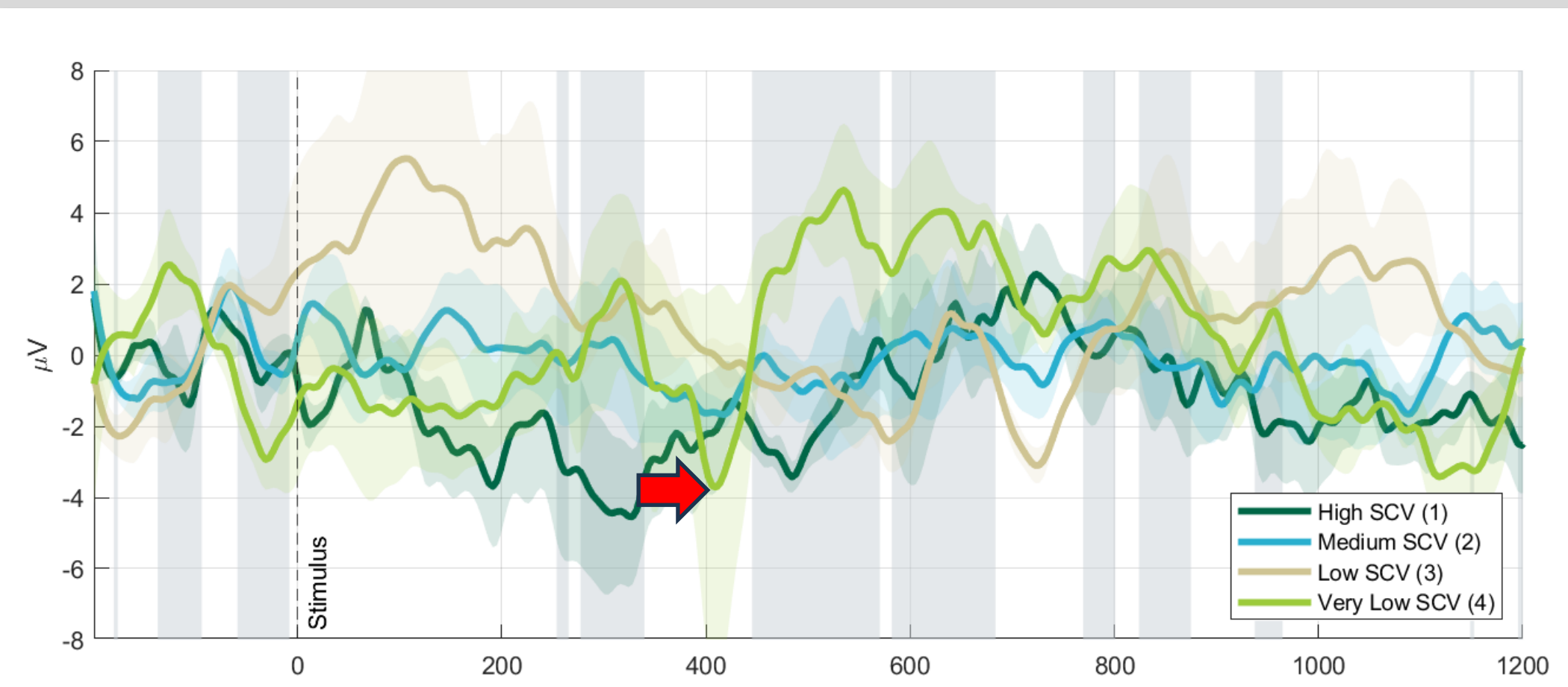


Figure 5. Preliminary Results: Social Difficulty ($d > 2$)

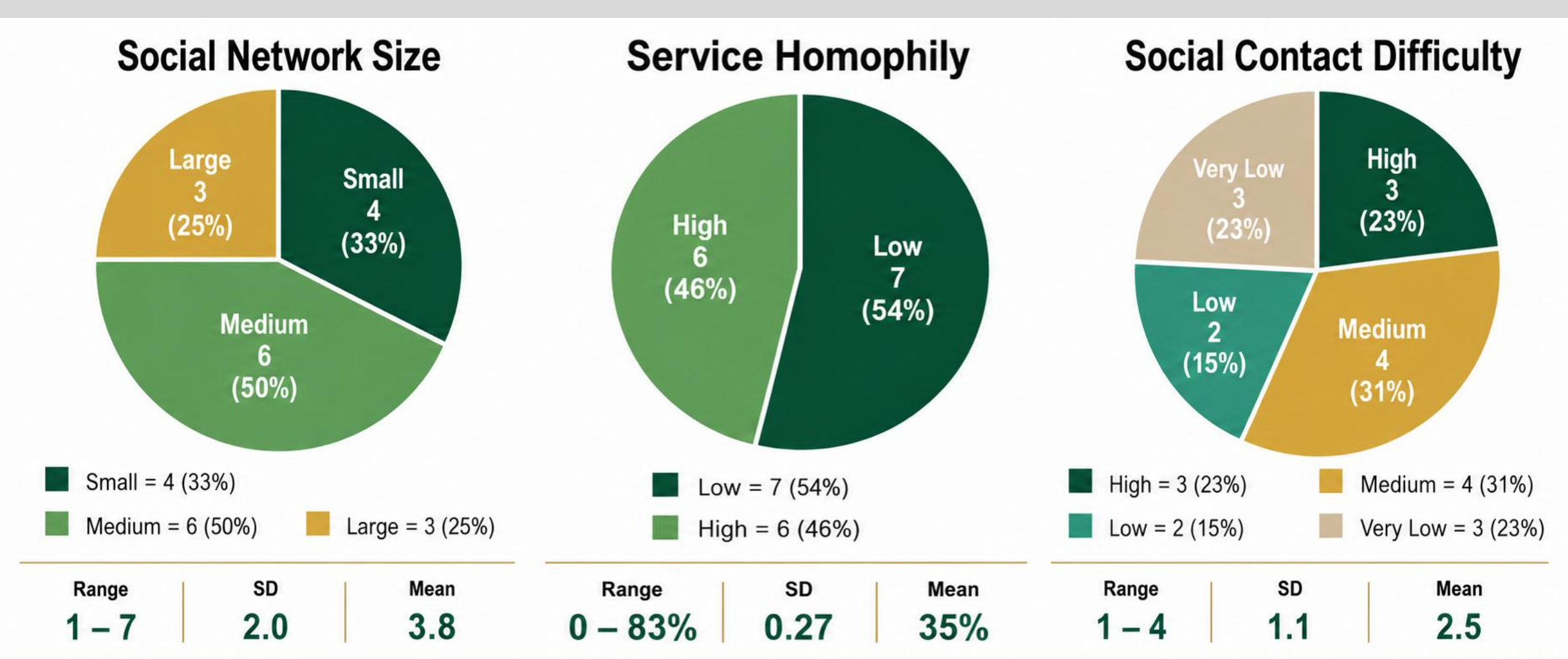


Figure 6. Preliminary Results: Network Attributes

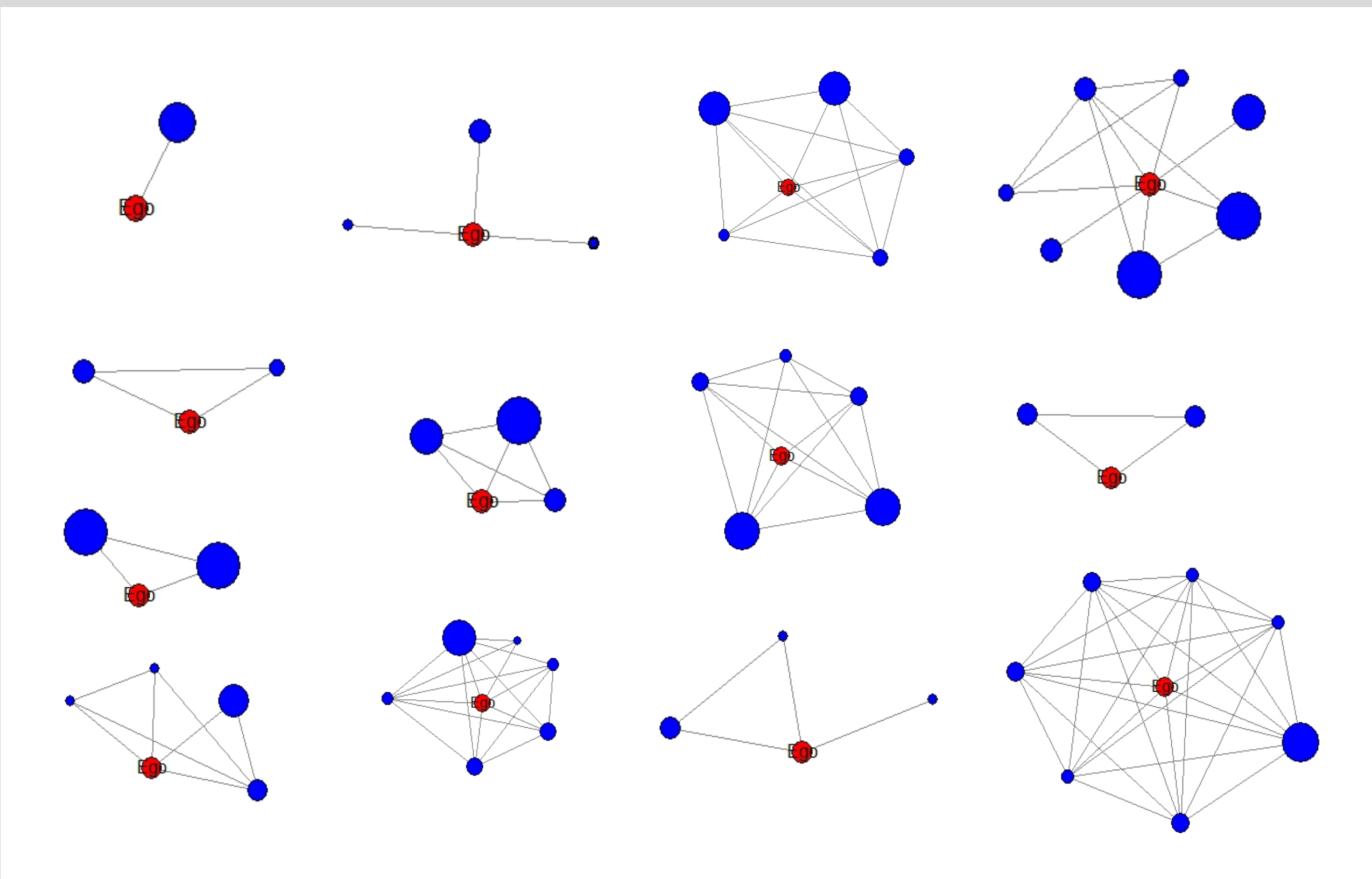


Figure 7. Preliminary Results: Egocentric Network Maps ($n=13$)

Interpretations

- Smaller social networks are associated with greater amplitude at N400ms—suggesting increased neural resources used during object identification (**Fig 3**).
- Service Homophily effects present at 800-1000ms—suggesting differences in decision stabilization (**Fig 4**).
- Social contact difficulty showed the strongest observed effects, more social difficulty showed pronounced neural effort at N400ms (**Fig 5**).
- Networks varied in configuration (**Figs 6, 7**).

Discussion

- This work builds a basic science framework for neuroanthropology—the study of culture and brain intersection.
- Provides preliminary evidence that social network configuration is measurably associated with differences in neural processing post-TBI.
- Social network atrophy is a consequence of TBI and a driver of recovery trajectories, making networks a strong potential intervention method.
- Addresses **NASEM TBI Roadmap** recommendations:
 - Rec. 1: Offers a rigorous and replicable path for measuring and integrating social domains into TBI recovery science, which
 - Recs. 2, 7: Supports person-centered care,
 - Recs. 3, 8: Informing scalable, standardized approaches for improving TBI care frameworks.

Future Directions

- Longitudinal design: 3 EEG/interview timepoints + 1 interview post-treatment across 6 months.
- Expand network metrics: density; gender; additional homophily attributes; relationship frequency; resource type; role multiplexity.
- Explore differences across injury severity.
- Refine social domain: implications optimize return-to-duty, sustained performance.
- Additional study to inform intervention.
- Explore sociocentric networks, as injury clustering within military battalions suggests embeddedness in larger communities matters beyond close ties.

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Conclusions Social networks among Veterans with mild-moderate TBI differed in diversity and organization of support resources. Preliminary analyses show **significant associations between social networks and brain activity.** Study advances a basic science framework for neuroanthropology; integrated BPSE and CBI+M; NASEM Recommendations.