

May I Help You? Predicting Help-Seeking for Robot Assistance in Challenging Environment

Tianqi Liu¹, Wei-Che (Harry) Lin¹, Yejoon Yoo¹, Saleh Kalantari^{*†1} and Andrea Stevenson Won^{*†1}

¹ Department of Information Science, Cornell University, Ithaca, USA

Contact: tl889@cornell.edu

Introduction

In challenging environments, people may become disoriented or unable to explicitly communicate their need for help.

Existing robot assistance often relies on:

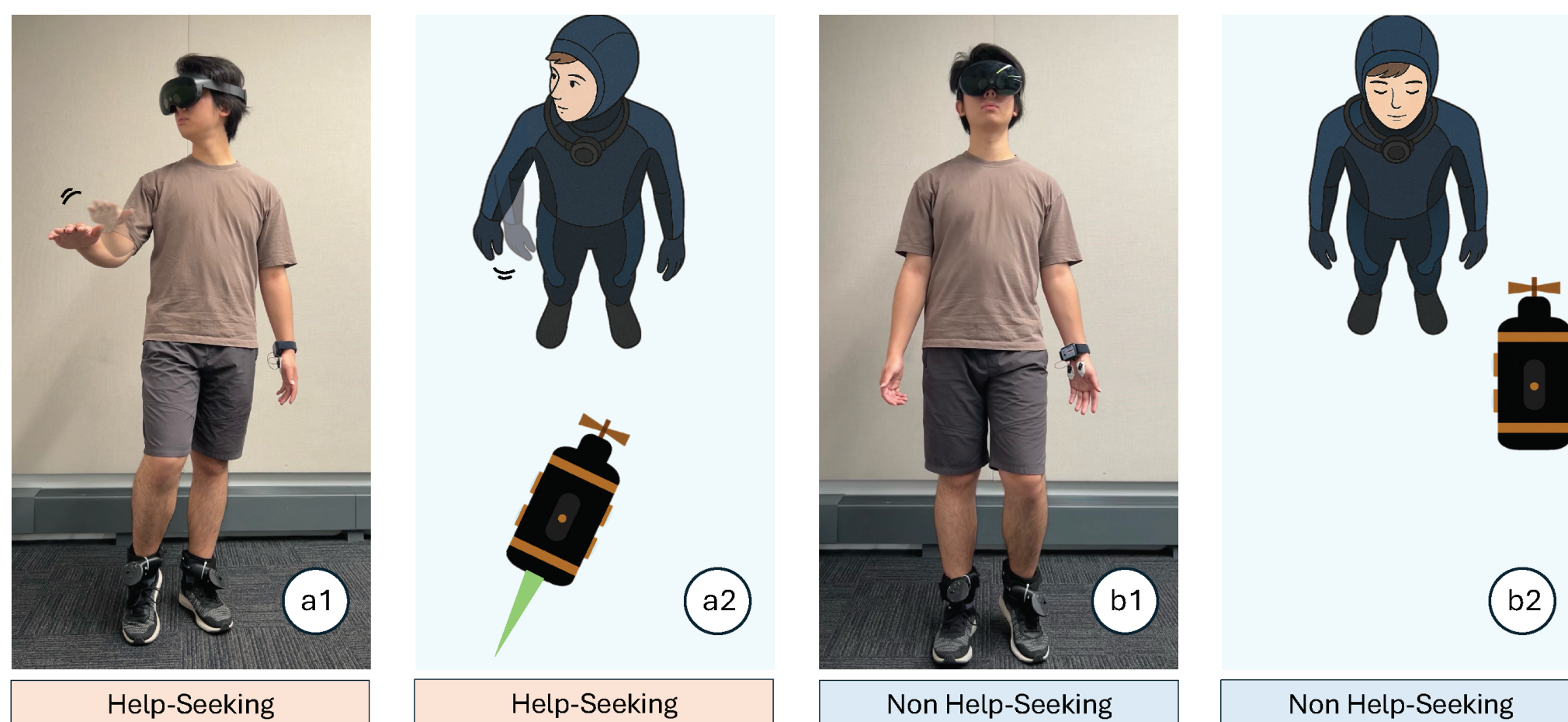
- Explicit commands - users may be unable to provide;
- Continuous guidance - limits human autonomy;
- Remote human control - requires additional human effort.

Proactive assistance requires robots to infer when users need help from external behavioral signals.

Research Gap: Prior work predicts human states such as confusion. However, these states do not directly indicate whether/when a user will request assistance.

Research Questions:

- Can a robot anticipate help-seeking** from users' observable behavioral and physiological signals before they explicitly request assistance?
- Which behavioral signals best predict help-seeking?
 - How do help-seeking indicators develop before an explicit request?



Study Design

VR-simulated challenging underwater wayfinding task

- 2 locomotion modes: controller and action-based locomotion
- 70 participants; within-participants
- 4 route segments per task
- Environmental challenges:
 - High vs. low visibility
 - Currents vs. still water
- Each participants requested robot assistance around 8 times

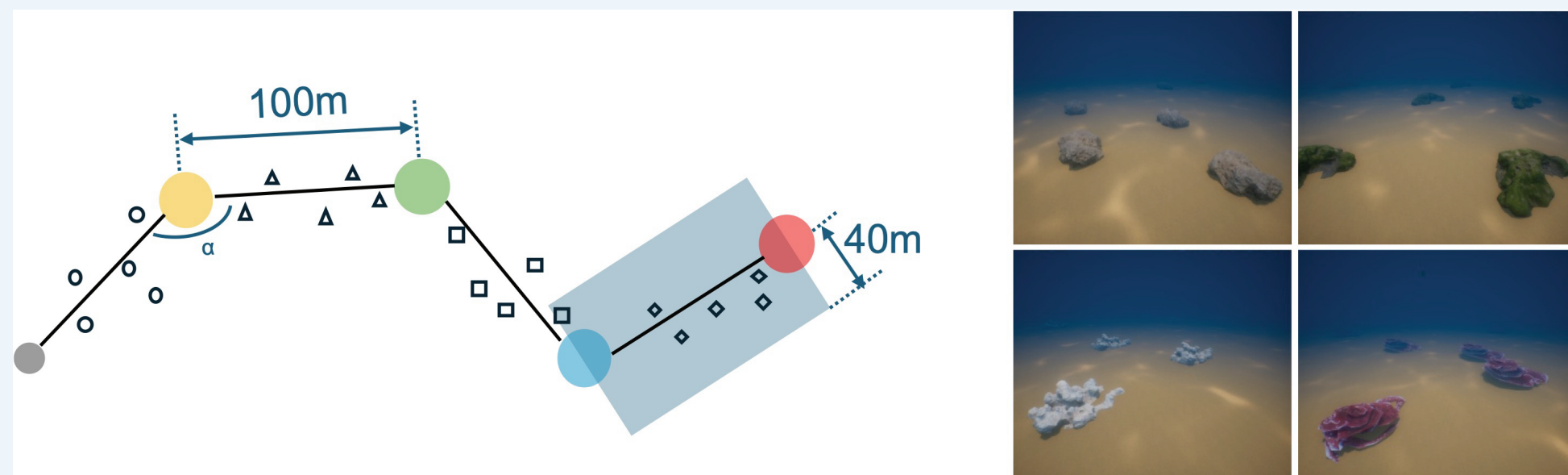


Fig. 1: Task design and experimental conditions.

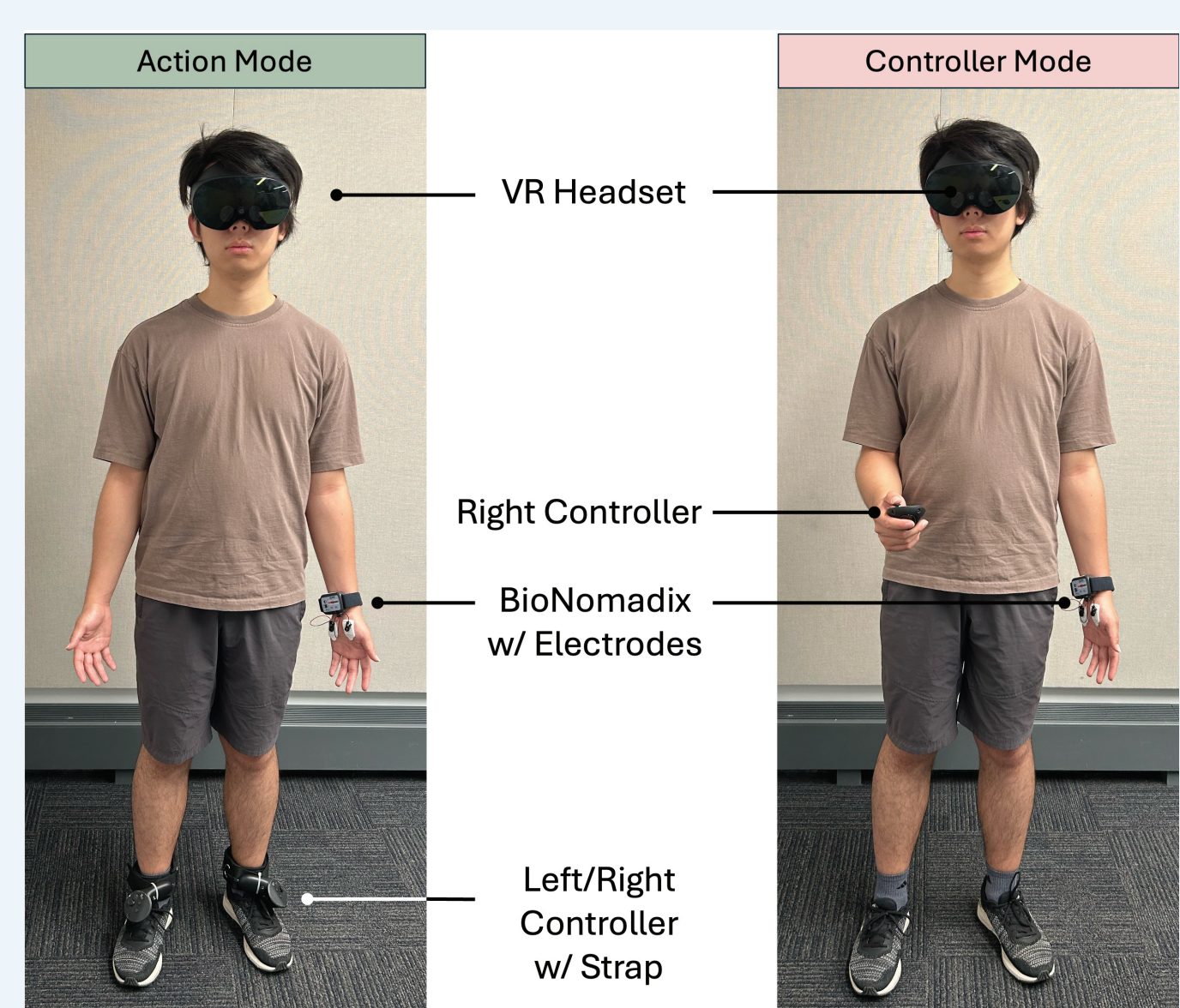
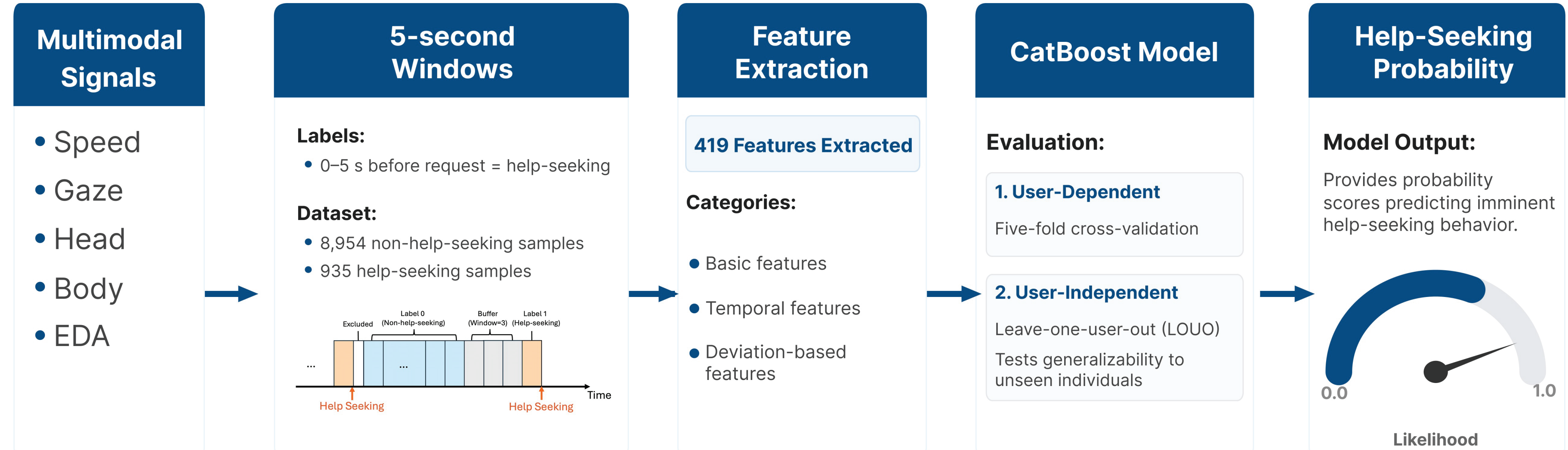


Fig. 2: Experimental setup for 2 locomotion conditions.

Reference:

- [1] Lyu *et al.* "Signaling Human Intentions to Service Robots." CHI, 2025.
- [2] Chen *et al.* "Need Help? Designing Proactive AI Assistants for Programming." CHI, 2025.
- [3] Stiber *et al.* "Uh, This One?": Detecting Confusion During Physical Tasks." ICMI, 2024.
- [4] Zhu *et al.* "Identifying Uncertainty States During Wayfinding." Advanced Engineering Informatics, 2022.

Prediction Pipeline



Results

Help-Seeking Can Be Predicted

Table 1: Help-seeking prediction performance

Model	Accuracy	AUC	Help-Seeking F1
User-dependent	94.38%	80.72%	71.71%
User-independent	93.35%	94.47%	68.51%

The user-independent model trained and tested on both controller mode and action mode generalized across unseen participants, achieving an AUC of **94.47%**.

Behaviors Predict Help-Seeking



Participants scanned the environment more broadly and slowed down as they approached a help request.

Help-Seeking Emerges Gradually

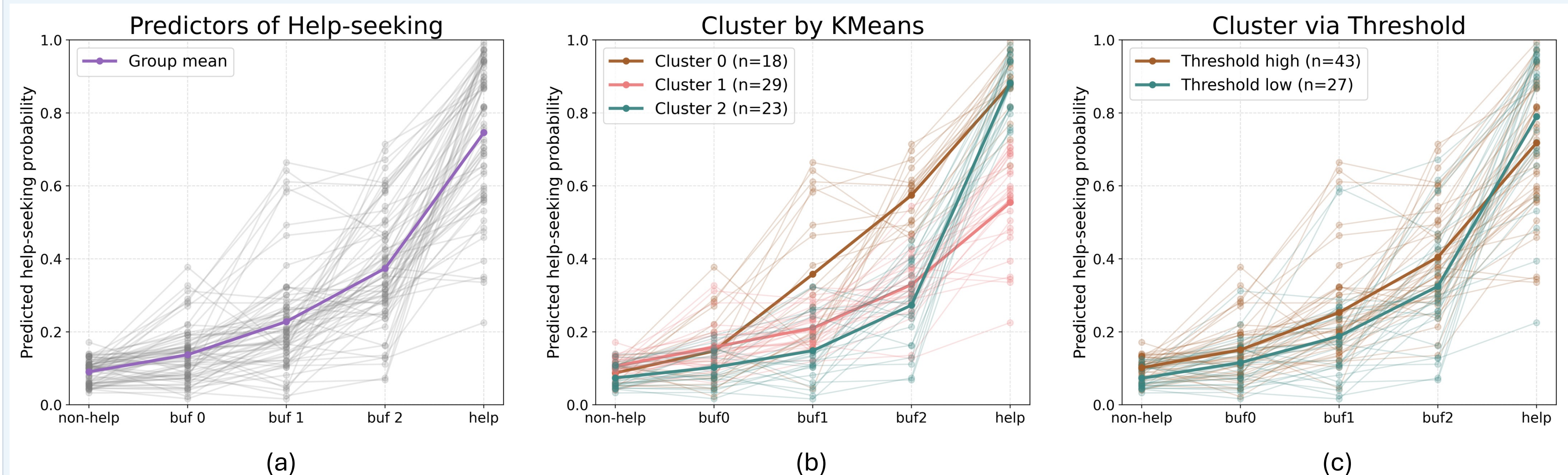


Fig. 3: Predicted help-seeking trajectories during the 20 seconds before a request.

- Predicted help-seeking probability increased during the **20 seconds** before a request.
- 3 temporal patterns: **Early increase**, **delayed request**: 25.7%; **Sharp increase**: 32.9%; **Modest change**: 41.4%, showing that participants differed in how quickly they requested help after becoming uncertain.
- **Different help-seeking threshold**: Participants with higher help-seeking thresholds showed earlier behavioral changes but delayed their explicit requests.

Design Insights

- Robots may monitor **gaze scanning**, **head movement**, and **locomotion slowdown** to anticipate assistance needs with accumulating evidence.
- Intervention thresholds should adapt to individual help-seeking preferences via **personalized calibration**.

Limitations

- The VR diving scenario did not fully reproduce real underwater movement and risk.
- The findings may not generalize to other types of help-seeking or collaborative tasks.
- The model was evaluated offline and has not yet controlled a proactive robot in real time.

Key Takeaway

Multimodal behavioral signals enable robots to proactively predict a user's emerging help-seeking state before an explicit request, including for previously unseen users.