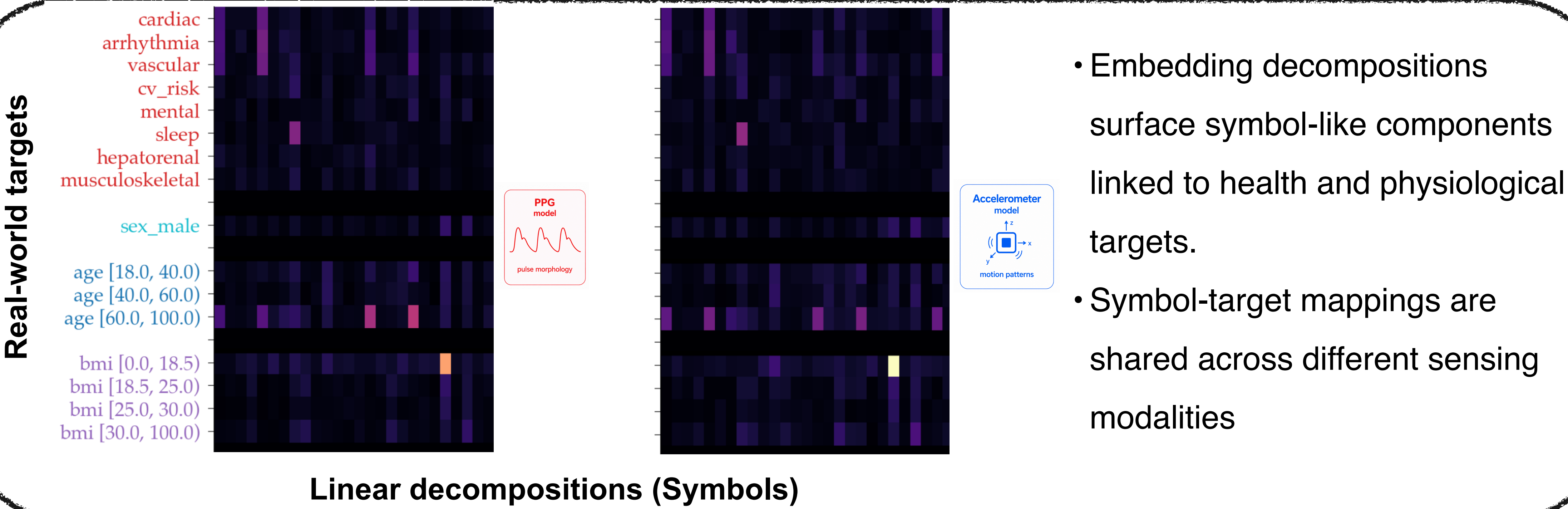


Emergent Symbols Enable Cross-Modal Transfer in Wearable Foundation Models

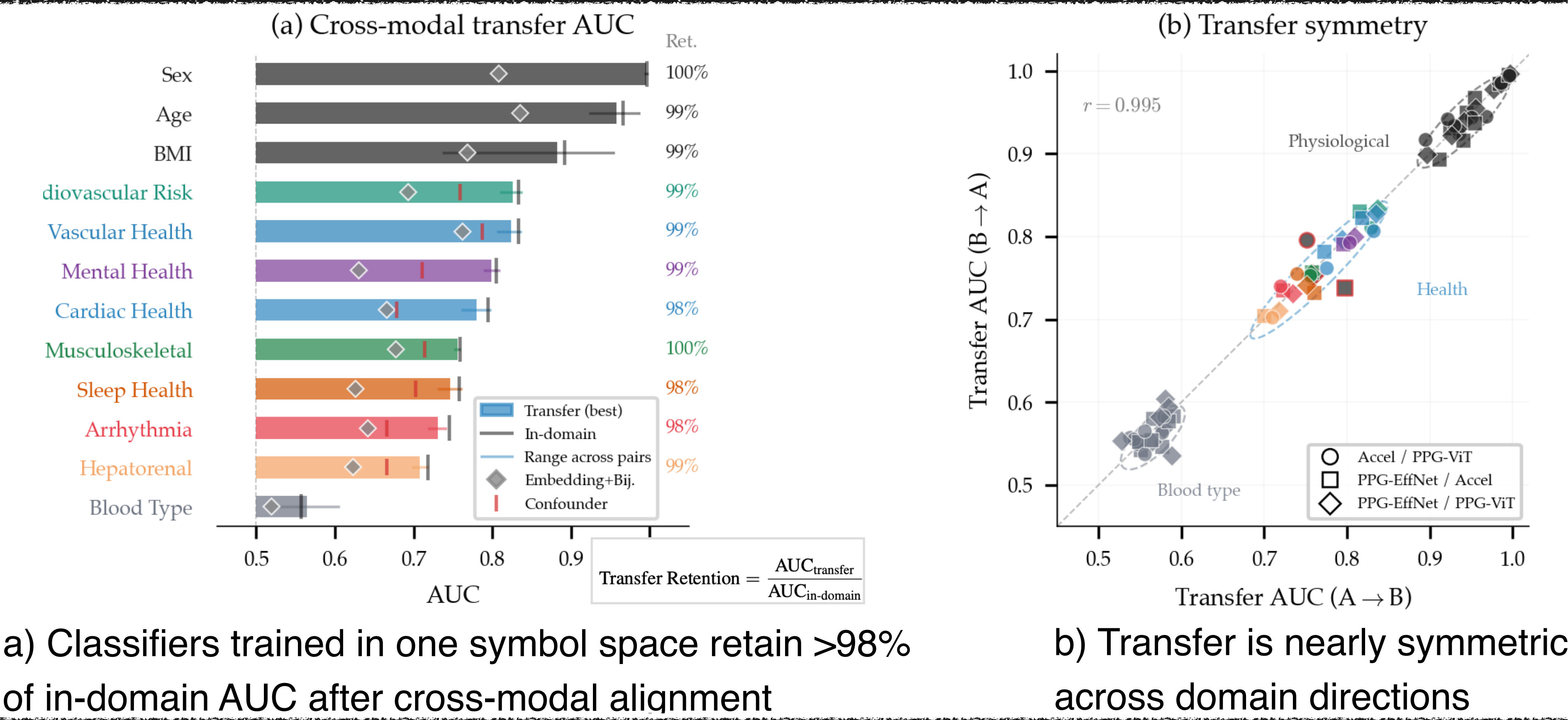
Emergent Symbolic Structure in Health Foundation Models: Extraction, Alignment, and Cross-Modal Transfer

Background: Wearable foundation models lack explicit symbols for structured reasoning, and neuro-symbolic integration offers a path toward closing this gap. As a first step, we surface symbol-like components from frozen embeddings and study how they improve interpretability and enable cross-modal transfer.

Symbol-like components reveal health meaning



Cross-domain transfer via symbols



Different sensors, same underlying body: wearable models converge on a physiologically rich shared representation.

Method:

- 3 separately trained FMs, each trained on ~20M minutes of unlabeled sensor (PPG or accelerometer) data collected from ~172K participants in the Apple Heart and Movement Study
- Symbol extraction using linear projection methods ICA, PCA, and NMF on subject-level aggregates of frozen embeddings; correlation-based alignment of cross-modal symbols; cross-modal transfer using aligned symbols.
- We use “symbols” operationally: as extracted embedding directions, not discrete logical predicates.