



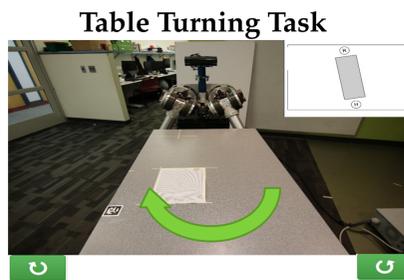
# Using Verbal Communication to Improve Adaptation in Human-Robot Teams



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## Motivation

Humans can form inaccurate expectations of robot capabilities which leads them to form *suboptimal strategies* to solve a joint task.



## Insight from Related Work

1. People use different communication modalities to best solve different tasks.
2. Verbal communication is more *descriptive* than nonverbal communication.
3. Conveying one's internal state allows teammates to *plan* and *predict* actions.

## Key Idea

A combination of verbal and nonverbal communication will encourage the human to switch to the optimal strategy while maintaining their trust, compared to nonverbal communication alone.

### Adaptability

Task A ✓  
 Task B ✓  
 Task C ✓

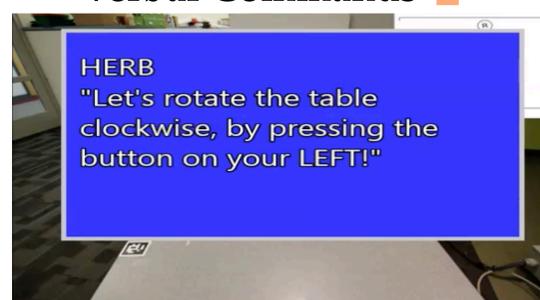
### Compliance

Task A ?  
 Task B ✓  
 Task C ?

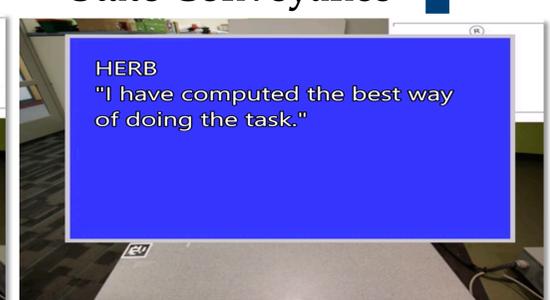
### Nonverbal Action



### Verbal Commands



### State Conveyance



## Method

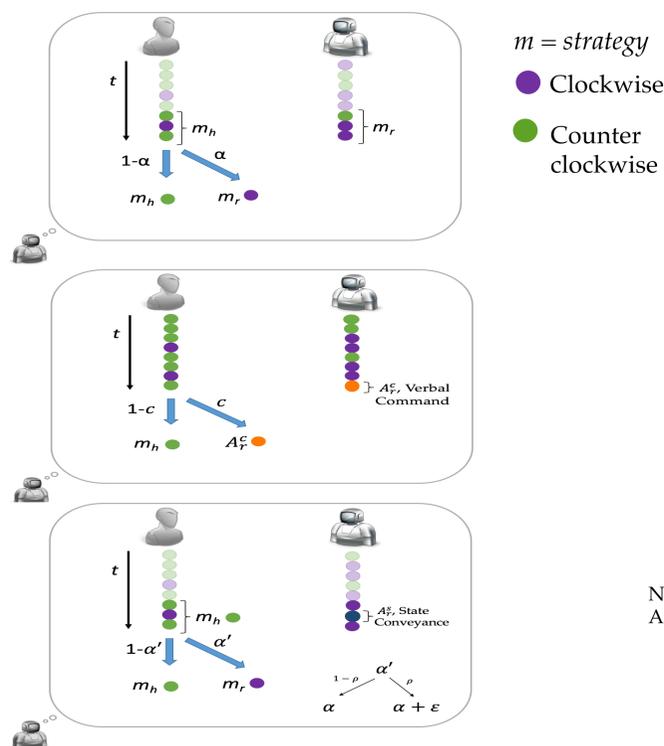
### MOMDP Formulation

**Nonverbal Action**  
 $X: X_{world} \times M^k \times M^k$   
 $Y: A, \alpha \in A$   
 $A_r: A_r^{world}$   
 Stable transition function

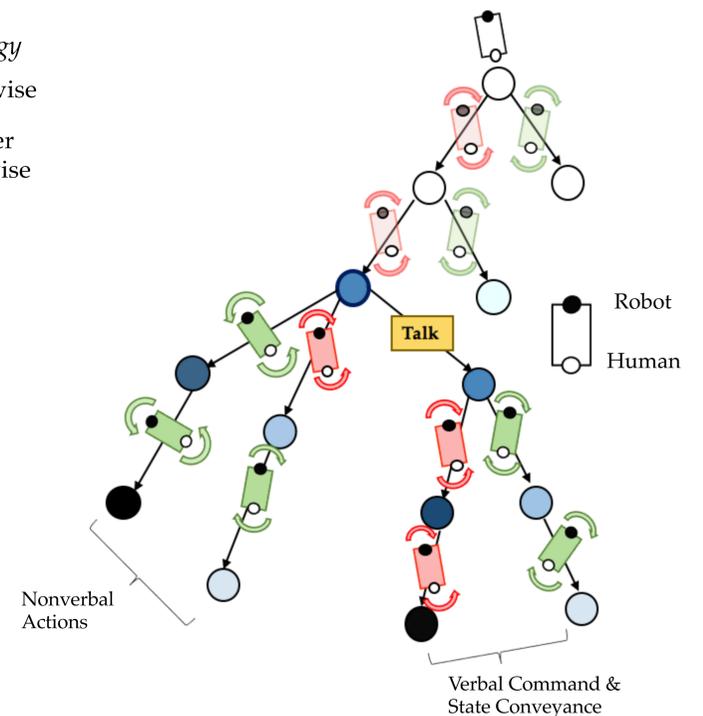
**Verbal Command**  
 $Y: A \times C, \alpha \in A, c \in C$   
 $A_r: A_r^{world} \times A_r^c$   
 Stable transition function

**State Conveyance**  
 $A_r: A_r^{world} \times A_r^s$   
 Dynamic transition function

### Predicting Human Actions

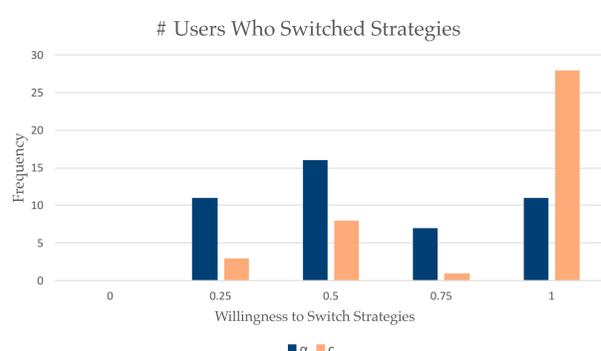


### Policy



## Evaluation

**H1:** Users are more compliant than adaptive.



**H2:** Verbal commands and nonverbal actions combined encourage more users to switch strategies while maintaining similar levels of trust.

