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Team Response to Stress: Implication for Human-Robot Interface

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INTRODUCTION

Many studies have been done on individual reactions to task-related stresses (e.g., workload). Traditional workload assessment relies on self-report, Likert-type instruments (e.g., NASA-TLX, SURG-TLX, 6-STAI), which are vulnerable to recall and observer biases. Thus, objective parameters such as physiological signals are often collected for analytic and statistical purposes on individuals.

However, advances in individual evaluation techniques have not translated to the team level: the team-based workload assessment (TBWA) is poorly developed, particularly in hierarchically organized teams. Common strategies include averaging individual workload scores, employing observer "time-out" ratings in simulation, or aggregate individual biometrics without modelling inter-member dynamics. When applying to human-robot interface designing, this problem becomes even more significant due to the vaguely defined role of the robot in the team.

Therefore, our study has two goals: 1) to scroll through the past literature in identifying approaches to describe the team stress, including constructing more effective evaluation algorithms; and 2) to propose design recommendations that enhance human-robot interfaces when encountering work-related stresses as a team.

MATERIALS AND METHODS

Literature review starts by defining keywords and various combinations following the Boolean operator guidelines. Specifically, terms in a row (physiological signals) are connected using the "OR" operator, while terms in a row (cognitive indicators) with the "AND" operator. There are 1343 literature being collected from PubMed, IEEExplore, and Medline. Studies involving hierarchical teamwork, team performance aggregation and health science settings are preferred. After filtering irrelevant literature, a total number of 30 papers are selected for this review.

RESULTS AND DISCUSSION

Across the literature, HRV/ECG, eye tracking and EDA are the major physiological signals being recorded in correlating the stress level. HRV/ECG signals work the best due to the recording feasibility under surgical settings and iconic characteristics in precisely mapping cognitive states. In speak of aggregation methods, interpersonal comparisons on classic HRV features (InRMSSD, SDNN, LF/HF ratio) are informative yet under representable for a role-dynamic, hierarchical team. We decided to use the **noise-assisted multivariate empirical mode decomposition (NA-MEMD)** to derive data-adaptive intrinsic mode functions aligned across teammates, and a role-specific weight allocation method that encodes clinical hierarchy, glitch rates, team familiarity and the phase-of-procedure. Individual data are collected separately but aggregated to a team level, where influencers to the physiological and cognitive metrics are cleaned out through applying background white noise to the data set during analysis.

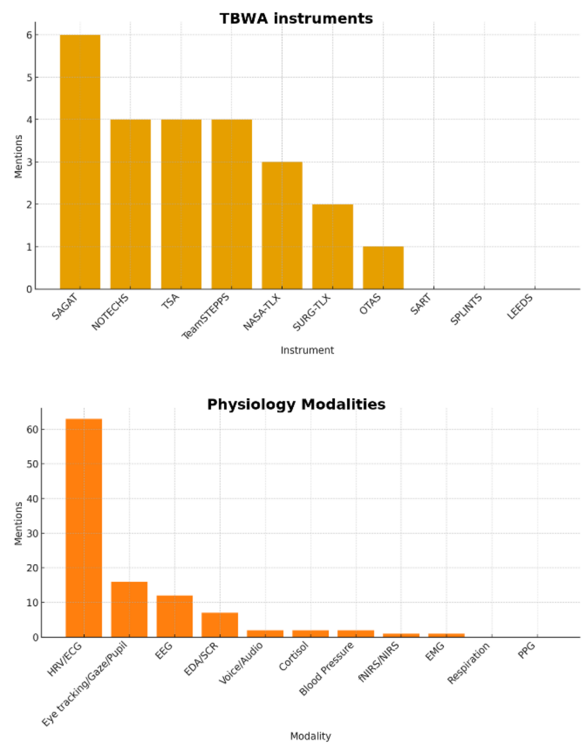

Fig 1: Cognitive Instruments and Physiological Metrics in Surgical Team Stress/Performance Literature.

CONCLUSIONS

This study offers concrete guidance for human–robot interface design and surgical algorithm optimization.

Phase-of-procedure and glitch-rate terms inform real-time multi-objective trade-offs, such as tightening precision during skin closure, while relaxing noncritical precision to prioritize speed during haemorrhage events. Together, these mechanisms yield actionable design suggestions for safer, explainable, and context-aware human-robot surgery.