Signaling Motions for communication in human-robot interaction

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Task-Consistent Signaling Motions for Improved Understanding in Human-Robot Interaction and Workspace Sharing

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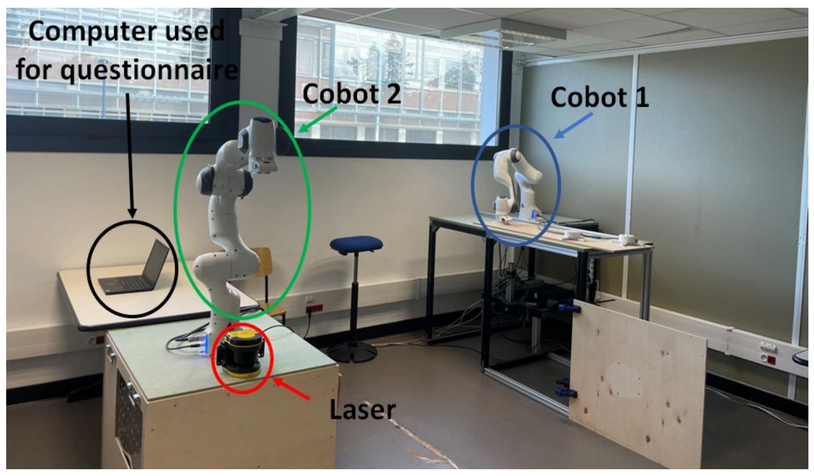
1 CONTEXT

The integration of collaborative robots (cobot) in industrial environments depends on their acceptance by operators and the potential for symbiotic work between these partners. The safety of operators is thus a priority in the implementation of these industrial environments.

The complexity and variability of tasks and workspaces can lead to hazardous situations for operators. It is therefore important to study the means of communication available to reduce risks in industrial environments.

In this work, it has been proposed to use the **cobot's motion** to **communicate** with an operator and improve his **performance** and **safety**.



2 SIGNALING MOTIONS

These communication motions are called **signaling motions**. They are superimposed on the main motion of the cobot (used for its task) using the unused degrees of freedom for the task. They allow to provide information to the operator about the task or the state of the cobot. The particularity of these additional movements is that they do not affect the main task of the cobot and only act as a complement.

In this work two signaling motions have been defined:

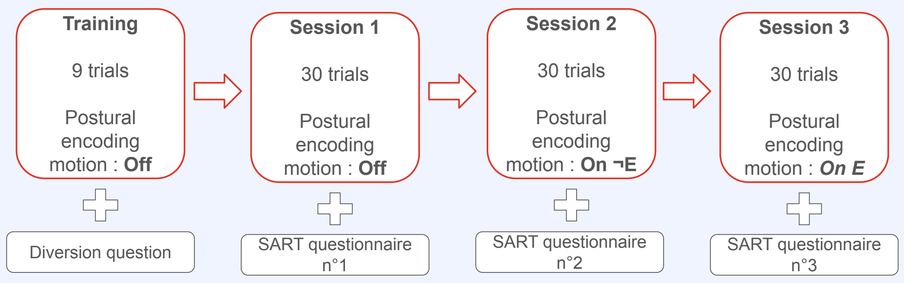
- An **explicit** motion: it is linked to the task, keeps the human involved in the task and helps in decision making;
- A **diffuse** motion: it is independent of the task, covers a wide range of contexts and user expertise and informs about the cobot status.

3 OBJECTIVES

The purpose of this work was to evaluate the effects of two signaling motions on participants task performance and behavior toward a cobot.

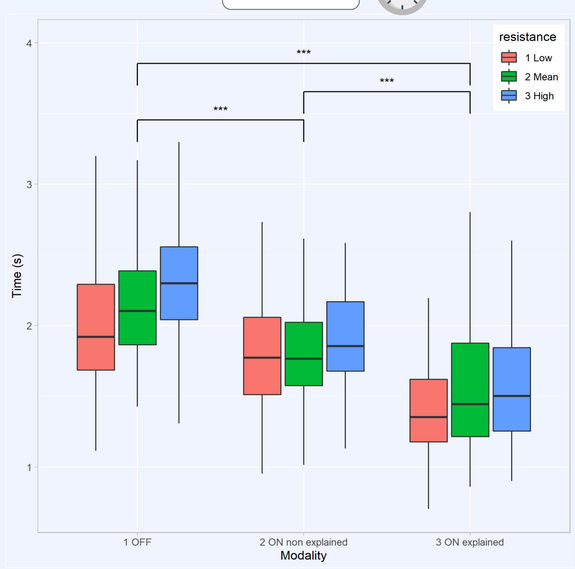
More specifically, the experiment consists of a simulated wood cutting task that requires a joint effort between a robot (Cobot 1) and an operator. In addition, the behavior of the individual is also studied when moving near a second robot (Cobot 2) sharing the same workspace.
- Cobot 1 performs an **explicit** motion during the task, called postural encoding. This motion is intended to facilitate the understanding and execution of the task.
- Cobot 2 performs a **diffuse** motion, called breathing. This motion aims to enhance the safety of the individual in the working environment.

4 METHODS

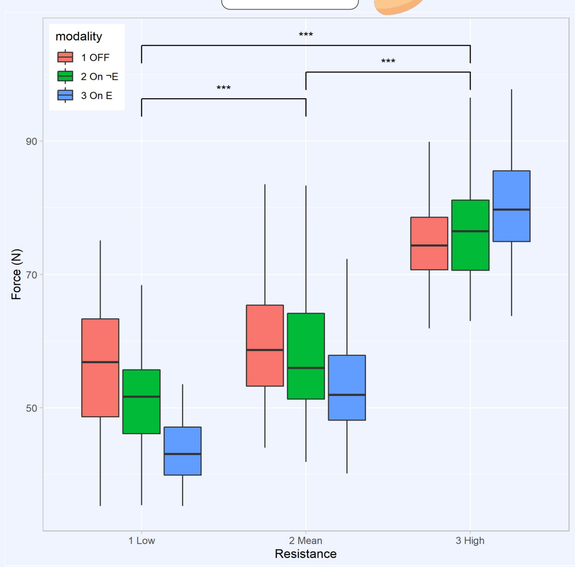


5 RESULTS

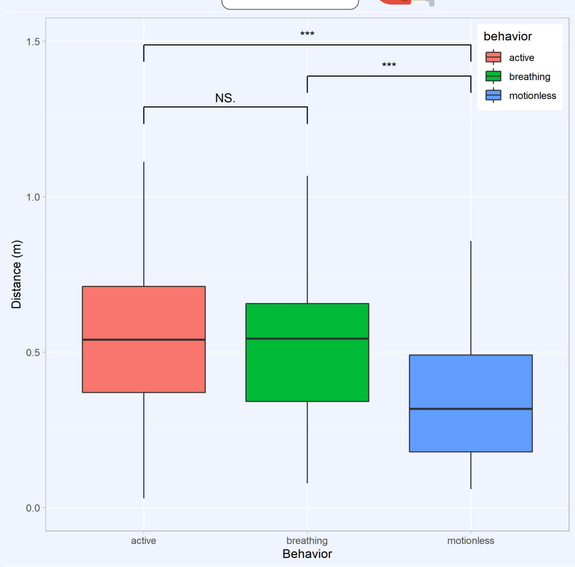
Time



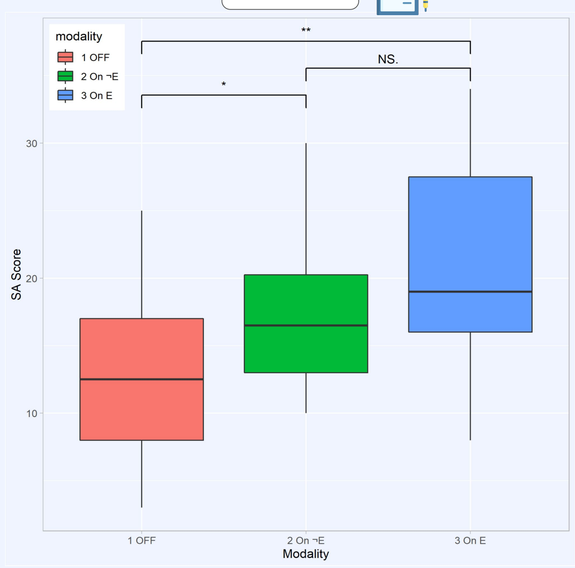
Force

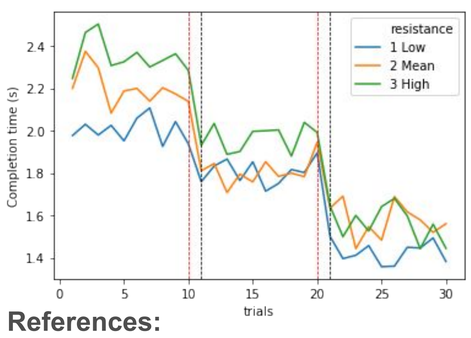


Distance



SART





6 CONCLUSION

The experiment does show a positive effect of both postural encoding and breathing motions on performance and safety.

The signaling motions appeared to enhance the participants mental model during interactions with the two cobots.

The results are not only caused by a learning effect. One one hand, a slight intra-modality learning effect can be observed on the completion time. On the other hand, a strong decreases can be observed if we look at the inter-modality differences.

References:

Benjamin Camblor, Nassim Benhabib, David Daney, Vincent Padois, and Jean-Marc Salotti. 2022. Task-Consistent Signaling Motions for Improved Understanding in Human-Robot Interaction and Workspace Sharing. In Proceedings of the 2022 ACM/IEEE International Conference on Human-Robot Interaction (HRI '22). IEEE Press, 275–283.

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