Using Virtual Reality to Assess Communicational Skills During a Collaborative Task with Time Pressure

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***Abstract*— Communication is an essential nontechnical skill, required in any activity involving social and professional interaction. This article presents an assessment of this specific nontechnical skill through a virtual reality (VR) simulation. The VR scenario used involve a team solving of a collective task under time pressure. We will describe the immersive environment as a tool for assessing communication skills. Twenty-three participants were included in the study and divided into four different groups. Qualitative and quantitative data were collected and will be presented to assess and compare team communication when performing a time-pressured collaborative task in an immersive environment. Three types of groups emerged, involving different and more or less effective communication.**

Keywords-virtual reality; communication; nontechnical skills; interaction; assessment; group.

I. Introduction

Communication is an essential nontechnical skill for any professional interaction. For industries, this nontechnical skill has been identified as a determining factor in the occurrence or non-occurrence of accidents in workplaces characterized by significant risks and interactions involving team working. To solve this problem, managers set out to deeply study this type of nontechnical skills, in situations analogous to those encountered in the real world of work, in order to improve safety and performance in the workspace. This study is part of a larger project undertaken by the "Behaviour" chair [1], based on a multi-faceted collaboration between researchers, industry and developers of VR scenarios. In this study, VR will be used as an innovative means to conduct communication research and analysis, providing a rich and diverse data source, a high level of realism and immersion, via a flexible and adaptable platform.

VR is used to define a computer-generated environment that can be experienced, explored, and with which a person can interact [2]. This person becomes an integral part of this virtual world via the immersion principle, and can then manipulate objects or perform a set of actions [3]. Notably, VR will be seen as an ideal means of implementing new frameworks that mimic real-life functions and situations [4] as it offers safe and flexible ways to create various environments that are easily reproducible and enables a variety of behavioral responses (e.g., language, actions, movements) to be accurately measured [5].

It has been widely demonstrated that successful teamwork depends on interaction and knowledge sharing between team members [6]. Moreover, communication has often been shown to be an important predictor of team and project performance [7]. In scientific literature, a number of studies have investigated group communication using VR [8]. However, these studies are mainly quantitative and do not highlight the qualitative aspect.

This article follows a structured outline. In Section 1, we detail the methodology employed for conducting this study. This includes an overview of our VR simulation tool, a description of the participants, and an outline of our procedural approach. Section 2 presents the overall quantitative and qualitative results obtained. Section 3 will be devoted to the concluding part, in which we will discuss our overarching findings, highlighting limitations, and outlining future prospects for our research.

II. Method

In this section, we describe the methodology used in our study. First, we describe the virtual reality scenario. We will then present the sample involved in the study. We will finish by explaining the procedure deployed.

A. Virtual reality simulation

The VR simulation involves a collective resolution of a task in an unusual environment. It reproduces an immersion in a submarine (Figure 1) in which the team must collaborate and communicate to succeed. This simulation was collaboratively developed by Virtual Rangers [9], a creation studio specializing in VR, in conjunction with researchers and industry experts.

Figure 1. virtual environment display.

The mission is to assemble different items produced by each participant into a final piece. The entire scenario, if successful, involves the production of 5 pieces within a given time limit. However, a number of rules must be observed including wearing the right safety gloves tailored to each item (chemical risk, explosion risk, etc.), assembling them in a particular order, and ensuring that team members choose the correct reference for each item, among other requirements.

The time pressure added by the virtual environment comes from the timer which is constantly visible to all participants. Moreover, every three errors a minute is deducted from the overall time. Another type of pressure comes from the red halo that lights up around every participant who makes a mistake. Participants are placed in an unconventional situation that generates stress through various disruptive and stressful elements.

B. *Participants*

A total of 23 participants aged between 21 and 25 (μ=22.5 years; σ= .97 years) were recruited to test the virtual environment. The participants were all 5th-year students from the same engineering school. They are volunteers, native speakers of French and have a strong interpersonal tie. Participants are part of the same graduating class and work on a joint project during their final year. It should also be noted that all the participants are testing this VR simulation for the first time.

C. *Procedure*

Participants who agreed to join the study were randomly divided into groups : three groups of six and one group of five. On arrival in the VR room, all participants consulted and signed a consent form. Next, the technical engineer described the context of the simulation, the general objective and showed them the controls to be used to perform actions in VR. During this briefing phase, they were free to ask questions to remove any ambiguity, as they had been told that during the simulation, they should and could only interact with each other. Participants were then fitted with VR headsets and hand-held controllers. A training phase is planned at the beginning of the VR so that participants can interact and familiarize themselves with the environment.

For data collection purposes, the setup incorporates a data recording function, enabling us to collect real-time verbal interaction, time spent to perform the task, video recording of their actions in the VR environment including number and type of errors.

III. RESULTS

In this third section, we detail the results obtained by analyzing our qualitative and quantitative data.

A. *Quantitative DATA*

The quantitative data we rely on are the time spent completing tasks and the number of errors made for each group and each part. (Figure 2).

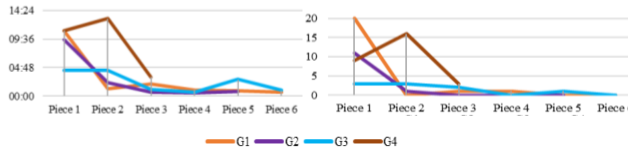

Figure 2. time taken and errors number per piece and per group.

As we can see, three types of group stand out. G1 and G2 have performances that improve considerably between piece 1 and piece 2, and stabilize from piece 3 onwards. Then, we have G3, which is relatively stable, with no significant variation in performance in the production of the 6 pieces. Finally, we have G4, whose performance fluctuates unexpectedly. Indeed, as Figure 2 shows, this group's performance is worse for piece 2 than for piece 1. The number of errors and the time taken increase for the second piece. This represents an unexpected result.

In summary, considering these quantitative data as performance indicators, G3 emerges as the top-performing group in the task, followed by G2, G1, and lastly, G4, which exhibits the highest number of errors (n=28) and a longer completion time compared to the other groups.

To better understand these variations, we will present the results of our qualitative data analysis in the next section.

B. *Qualitative DATA*

Analysis of qualitative data has enabled us to understand more precisely the communication that distinguishes these different groups. In general, there is a noticeable contrast in the communication dynamics employed for the production of the initial pieces compared to the final ones across all our groups. The discursive sequences produced for the construction of the initial pieces were significantly longer than those generated for the construction of the final pieces. For the initial ones, these sequences were less structured, leading to co-comprehension processes, co-construction, and sense negotiation. By contrast, the final pieces contain increasingly operative language that is concise, unambiguous, shared and subject to less interpretation. Overall, these global results are applicable to all groups. Indeed, for the production of the first piece, we observe, a poorly structured communication, with a lot of overlapping speech and long, complex sentences *"But then, I'm preparing the detonator for you, and I'm preparing the propeller, so the propeller is an S631, at risk of corrosion".* For the last pieces, we observe the use of very short, clear and intelligible operative phrases such as: *"that's it"*, *"it's sent"*, *"ok"*. As the simulation progresses, most groups acquire increasingly precise, short and explicit communication. However, as the results of the quantitative data analysis show, G4 performed less well on piece 2 than piece 1. This unexpected result will

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provide us with further information on the importance of communication for this type of task.

For the G4, we observe an increase in lengthy interventions (when we compare the production of the piece 2 by the 4 groups) while for the other three groups, we observe a progressive decrease in the number of verbal interventions produced by the participants. Our analyses also revealed an important number of verbal interventions attesting a lack of involvement in achieving the team's objective: *"You think we can knock his tower down [Laughs]"*. This form of intervention, which hinders task resolution, is predominantly observed in G4, particularly during the production of the second part.

Another interactional phenomenon observed in the lowest-performing group concerns humor. In the other groups, humor was more likely to occur at the end of each phase, indicating a more relaxed atmosphere "*done, we can barbecue now"* than a lack of involvement and seriousness. Indeed, in the case of G4, humor was predominantly generated incidentally by participants, during the execution of the simulation.

Compared with other groups, help is less given when asked *"can you guys help him because I can't see what he needs to send"*. In G4, this type of intervention may go unanswered. These kinds of interactional behaviors were not observed in the other three participant groups. On several occasions, we also note that the same questions were asked several times by different participants. Compared with the other groups, G4 participants made fewer requests of the commander, and updated their situation less frequently *"wait a minute, i printed the wrong piece"*.

On the basis of our various analyses, we can conclude that this simulation enabled us to distinguish the performance levels of the groups in a fairly consistent way. The shortcomings mentioned in terms of communication skills are in line with our quantitative data. The groups with the least effective communication are characterized by a longer execution time and a higher number of errors.

IV. CONCLUSION

We are convinced that new immersive technologies, such as VR, can make a real contribution to the study of nontechnical skills, such as communication. This project, which brought together industrialists, researchers and VR experts, enabled us to study a standardized situation generating complex group dynamics. Being able to experiment and study this type of situation represents a real challenge, as part of a continuous improvement, training and learning process. Indeed, this research proposes a non-domain-specific immersive environment and investigates its role in assessing communicative skills. The vast majority of current studies investigating specific NTS do so via domain-specific VR, such as medical VR. The methodological protocol used in this study is useful both to professionals for continuing education and occupational risk reduction purposes, and to researchers for the study of different interaction situations. Future research will concentrate on a different demographic, specifically targeting professionals already employed in various industries. It would be interesting to compare the interactions/communication skills of future professionals with those who are already professionally inserted. We will also look at the debriefing process that takes place at the end of each simulation, enabling participants to engage in a process of reflexivity to improve their communication skills. For future research, the VR simulation employed can also be viewed as a method for establishing an appropriate environment conducive to smart education [10]. In this perspective, we aim measure the long-term effects of VR training on communication skills.

Further research will address some of the limitations identified in this preliminary study. Specifically, it is crucial to enhance the sample size for better generalization of the obtained results. In the course of this study, we mitigated the influence of personal relationships by deliberately choosing participants who were well-acquainted with each other and had prior collaborative experience. Moving forward, it would be prudent to consider and control for additional factors that could influence group performance, such as personality traits.

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