Collecting Data for Digital Human Modeling During the COVID-19 Pandemic

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ABSTRACT

In the past few years, the world witnessed a global pandemic due to the widespread of the COVID-19 coronavirus. There are reasons to believe that the associated measures adopted by the respective governments to reduce the spread of the COVID-19 incidences had a drastic impact on the acquisition of subject data. Digital human modeling as many other disciplines of human factors relies on data gathered in participant studies. This led to a massive delay in studies that started before and during the pandemic. This paper compiles protective measures for the acquisition of subject data. Technical, organizational, and personal measures to protect conductors and subjects of studies are presented for future reference.

Keywords: Protective measures, Digital human modelling, Data collection, Subject study COVID-19 pandemic, Protective measures, Hygiene concept

INTRODUCTION

On March 17th, 2020, the German government resolved a lockdown starting March 22nd, 2020, spanning throughout all societal sectors due to the widespread of the COVID-19 pandemic. Nobody but the most essential workers were allowed to go to their workplaces. Since researchers in human factors are not considered essential workers, the lockdown affected experiments heavily. Even as governmental measures became less strict, it remained a key subjective to prevent an outbreak among research personnel and participants. The preparation of the collected results presented here is aimed at researchers and study conductors and is intended to give them insight in the experiences gathered throughout the pandemic.

Different institutions like WHO (WHO, 2021), CDC (CDC, 2021a, 2021b), ISSA (ISSA, 2021) have published and continually updated their recommendations. Adam et al. (2021) have compiled lessons learned from 52 experts from 33 German companies for the handling of the pandemic and comparable situational crises. All these guidelines contain measures, that are also applicable for the collection of data for digital human modeling. Additionally certain particularities need to be considered when conducting a study for digital human modeling.

BACKGROUND

Digital Human Modeling requires experimental data collected with participants (Faraway & Reed, 2007). Subject data is used for model synthesis and/or validation of models (Bubb et al., 2006; Obentheuer, 2020; Reed et al., 2006). The data is selected according to the desired model and can be motion capture data, videos, EMG and many other. In the past this has mostly been connected to extensive laboratory experiments due to the expensive equipment and long setup times. Before the pandemic participants could be invited to the laboratory without extensive precautions. While surfaces with skin contact were disinfected, further hygienic measures were rare. Even though the COVID-19 pandemic required reduction of personal contacts it is still not feasible to collect all data without close human interaction as for example motion trackers or EMG need to be attached by experts.

METHOD

The measures described are based on the experiments conducted by Wirsching and Fleischer (2022) and the exchange with other human factor researchers at the Chair of Ergonomics at the TUM School of Engineering and Design at the Technical University of Munich. All of them needed to conduct laboratory studies during the COVID-19 pandemic at the chair and other research institutes. The measures taken by the researchers were collected and analyzed and sorted according to the STOP-principle (substitutional (S), technical (T), organizational (O) and personal (P)).

RESULTS

The substitutional (S), technical (T), organizational (O) and personal (P) protective measures are described in the left column Table 1. The right column provides an explanatory text for better understanding. Table 2 contains a variety of further key aspects of gathering subject data during a pandemic situation.

DISCUSSION

With the measures described in this paper, a series of experiments have been conducted without any outbreaks among conductors and subjects. While the measures cannot be transferred to any pandemic, they might be applicable to other crises. The pandemic made participant studies more time intensive and expensive due to the required hygienic measures. While before the pandemic basic hygienic measures like disinfecting surfaces with skin contact were taken, expanding these slowed down the process. Working with more caution and reducing the contact to the participants to the required minimum more effort is needed to run the experiment smoothly. And while the measures taken during the pandemic reduce the risk of sickness of participants and researcher, the additional efforts need to be outweighed by the risk. This is likely not the case after the pandemic but should be considered when working with persons in a high-risk group.

Table 1. Protective measures their explanatory texts.

Protective measure	Explanatory text
Digitalize (S,T)	In the context of digital human modeling, substitution of physical experiment is often not possible. Other human factors disciplines can use online questionnaires, digital prototypes or cardboard VR. For motion capturing or anthropometric studies, an expert is nearly always required. But to minimize the contact time between subject and conductor, preceding questionnaires should be digitalized and conducted by the participant at home.
Distance (T)	Even though using adequate personal protection is always advised, there are several possible reasons to let participants take off their masks during the experiment: • Physically straining tasks • Motion capturing technology relying on facial features • Eyetracking • Psychological influence of the behavior • Limited field of view • … While there is no reason for the conductors to take their masks off, it is highly advisable to keep a distance as wide as possible to the unmasked subject.
Aerosol barriers (T)	Additional to masks or in scenarios, where the subjects cannot wear any mask, aerosol barriers (acrylic glass etc.) should be deployed as often as possible.
Forced ventilation (T)	Depending on the location of the experiment, it is possible to ensure forced ventilation during and between the experiments. This reduces the aerosol exposure.
Ventilation pauses between subjects (T)	Independent of the availability of forced ventilation, a pause of at least 30 minutes between each subject with opened windows should be done.
Single use products (T)	Whenever using items that come into physical contact with the participant, it is advisable to use one-way products or one-way coatings.
Disinfection between subjects (T)	If one-way products are not applicable (mostly due to costs), every surface of the lab needs to be disinfected.
Conduct experiment in isolated environment (T,O)	In digital human modeling experiments, often expensive equipment like motion capturing devices is required. The laboratories may be located among other laboratories or offices generating a participant flow colliding with non-related researchers or subjects. Thus, isolating the experiment from offices and other laboratories is advisable to reduce contacts.
Isolate conductors (O)	While most of the measures described previously come with low restrictions of the personal rights of the conductors, this measure can never be demanded and is purely voluntary. To reduce the risk of infection among the team and the subjects, it is advisable to reduce every other contact, be it private or professional to the absolute minimum independently of the legal requirements.

Table 1. Continued.

Protective measure	Explanatory text
Artificially slowed down experiments (O)	While the isolation of the conductors can be an inconvenient and even psychologically demanding measure, the risk of having a widespread infection event can also be mitigated through stretching the study over a longer period. This gives the chance of reacting to seasonal trends and to divide conductors and subjects into small groups.
Contact tracing (O)	While there are many efforts in the EU to protect the privacy of their citizens, conductors should keep a list with contact information of the subjects, to be able to react to an outbreak.
Daily testing for conductors (P) (and subjects)	Conductors should be tested daily due to their high exposure to people during the experiment. If there is any way to enforce, subjects should also be tested negative before entering the laboratory.
FFP2/N95/KN95-masks for participants and study conductor (P)	Above many technical possibilities to reduce the risk of an outbreak are described. These measures can rarely be implemented throughout the duration of the experiment. Anthropometric measures, attachment of sensors etc. require close contact between conductor and subject. Under these circumstances, conductor and subject need to wear FFP2/N95/KN95-masks for best protection. Additionally, conductors should take care, that the mask has direct contact to the facial skin. This is mostly prevented by facial hair.

Table 2. Key aspects and their explanatory texts.

Protective measure	Explanatory text
Travel restrictions	One of the main disruptions at the start of the pandemic were the fast effective travel restrictions. This prevented some experiments where conductors needed to be present.
Working restrictions	While internationally different restrictions on on-site working were put into place. Researchers have an arguably large part of office work, which can be done at any location equipped with a PC and internet. In many cases, the only real exception are experiments. To facilitate better availability of experiment capacities, mandatory home office for every person not conducting experiments can be put in place.
(Medical) Ethics committee	While the measures described in Table 1 are already a solid start, pandemics are volatile. Thus, working with an ethics committee should be taken into consideration.
Harder recruitment	Recruitment is increasingly hard in times, during which contact reduction is highly advised. This could be mitigated by communicating a convincing hygiene concept and increased compensation for the subjects.
Reevaluation on a monthly base	With the dynamic pandemic developments and changing legal restrictions, every measure taken needs to be reevaluated on a regular basis.

Experiments for the acquirement of data for digital human modeling are heavily reliant on expensive and thus centralized equipment. Motion capturing, anthropometric measurements or eye tracking would need cheap and easy to handle alternatives in a way how cardboard VR can sometimes substitute expensive VR headsets. For DHM to be crisis-proof in the future, the technology used to generate data needs to be cheaper, more mobile, and operable by non-experts. If this is not possible, technical solutions to eliminate the contact between researcher and participant.

Lastly, it needs to be said that many of the hygiene measures (ventilation, single use products etc.) contradict many environmental efforts. This raises a need to minimize conducting experiments just like the need for data minimization. The missing standardization in data procurement and provision in digital human modeling poses a contradiction to that.

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