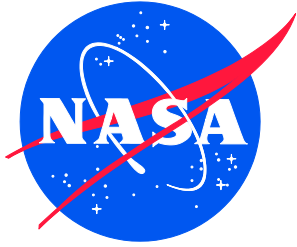


NASA/TM–20210018458



Guidance and Lessons Learned from COVID-19 for Human-Subjects Research

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Universities Space Research Association, Columbia, Maryland

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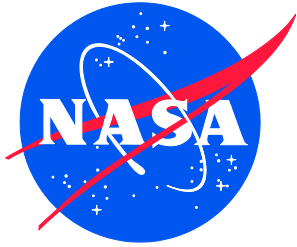
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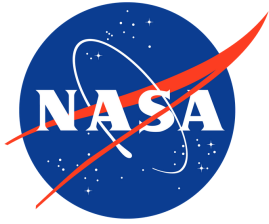
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Guidance and Lessons Learned from COVID-19 for Human-Subjects Research

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June 2021

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Executive Summary

3

Our **goal** was to identify innovative strategies, approaches, and methods that have enabled researchers to continue doing meaningful human-subjects research during the COVID-19 pandemic. Many organizations and recent literature primarily focus on efforts for future research in a post-COVID environment e.g., extending research funding opportunities, return-to-work, etc.¹⁻¹² Additionally, there have been no systematic efforts across the agency or broader human factors community to coordinate or share strategies. Therefore, our **focus** was on acquiring knowledge gained by researchers from experiences during COVID that could be valuable to continue human-subjects research under existing restrictions.




Introduction: The when

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Coronavirus disease 2019 (**COVID-19**) is a disease caused by severe acute respiratory syndrome coronavirus 2, or SARS-CoV-2. COVID-19 spreads when airborne droplets from an infected person land in the mouths or noses of people who are in close contact (**within 6 feet**).¹³ The first known case was identified in Wuhan, China in **December 2019**.¹⁴ The timeline below shows the progression of restrictions for the country and NASA in response to COVID-19.

 **MARCH 11, 2020** The World Health Organization declares COVID-19 a **pandemic**.¹⁵

 **MARCH 17, 2020** NASA leadership elevates all centers and facilities to **Stage 3** of NASA’s Framework for Return to On-site Work.¹⁶

NASA’s Framework for Return to On-Site Work¹⁷

	STAGE 3	STAGE 2	STAGE 1
CENTER ACCESS	<ul style="list-style-type: none"> Mandatory telework On-site work is limited to mission essential and approved mission critical work. 	<ul style="list-style-type: none"> Employees who must be on-site to perform their work may return on-site with center /supervisor approval. All other employees will continue to telework. 	<ul style="list-style-type: none"> Full access. Telework is encouraged for employees who can accomplish their work remotely, with supervisor approval.
MEETINGS & EVENTS	<ul style="list-style-type: none"> Conduct virtual meetings with remote participation only. 	<ul style="list-style-type: none"> Social settings or meetings of more than 50 people should be avoided unless pre-cautionary measures are observed. 	<ul style="list-style-type: none"> Conduct virtual meetings and participate remotely, when possible. Reduce in person meetings and large gatherings.

 **MARCH 19, 2020** Under Stage 3, NASA in-person on-site research is halted.

Introduction: The when

5



APRIL 28, 2021

Johnson Space Center goes to **Stage 2**.¹⁸

	STAGE 3	STAGE 2	STAGE 1
CENTER ACCESS	Blue	Red	Blue
MEETINGS & EVENTS	Blue	Red	Blue

- Employees who must be on-site to perform their work may return on-site with center/supervisor approval.
- All other employees will continue to telework.
- Social settings or meetings of more than 50 people should be avoided unless precautionary measures are observed.



MAY 16, 2021

The **Center for Disease Control** (CDC) announces that fully vaccinated people can resume activities without wearing a mask or physically distancing.¹⁹



PRESENT DAY (JUNE 17, 2021)

	STAGE 3	STAGE 2	STAGE 1
CENTER STATUS	Ames Armstrong Glenn JPL Kennedy Langley	Goddard Johnson Marshall Stennis	

²⁰



WHEN WILL EVERYTHING RETURN TO **NORMAL**?

When will we be able to resume on-site in-person human-subjects research? Even in Stage 1, will there be lasting effects or implications for how researchers conduct research?

Purpose: The why

6

Goal: Identify innovative strategies, approaches, and methods that have enabled researchers to continue doing meaningful human-subjects research during the COVID-19 pandemic.

Focus: Acquire knowledge gained by researchers from experiences during COVID that could be valuable to continue human-subjects research under existing restrictions.

Why is this important if the COVID restrictions are going to be lifted soon?

1 We don't know exactly when that will be.

Although it seems like we're nearing the end of the pandemic with the new vaccines, evidence is limited on the effectiveness of those vaccines against new COVID-19 variants as the virus continues to evolve.²¹

2 We can begin to find ways to prepare for the next pandemic.

The last global pandemic, the Spanish flu, happened about a century ago, but we can not know when another pandemic might occur.

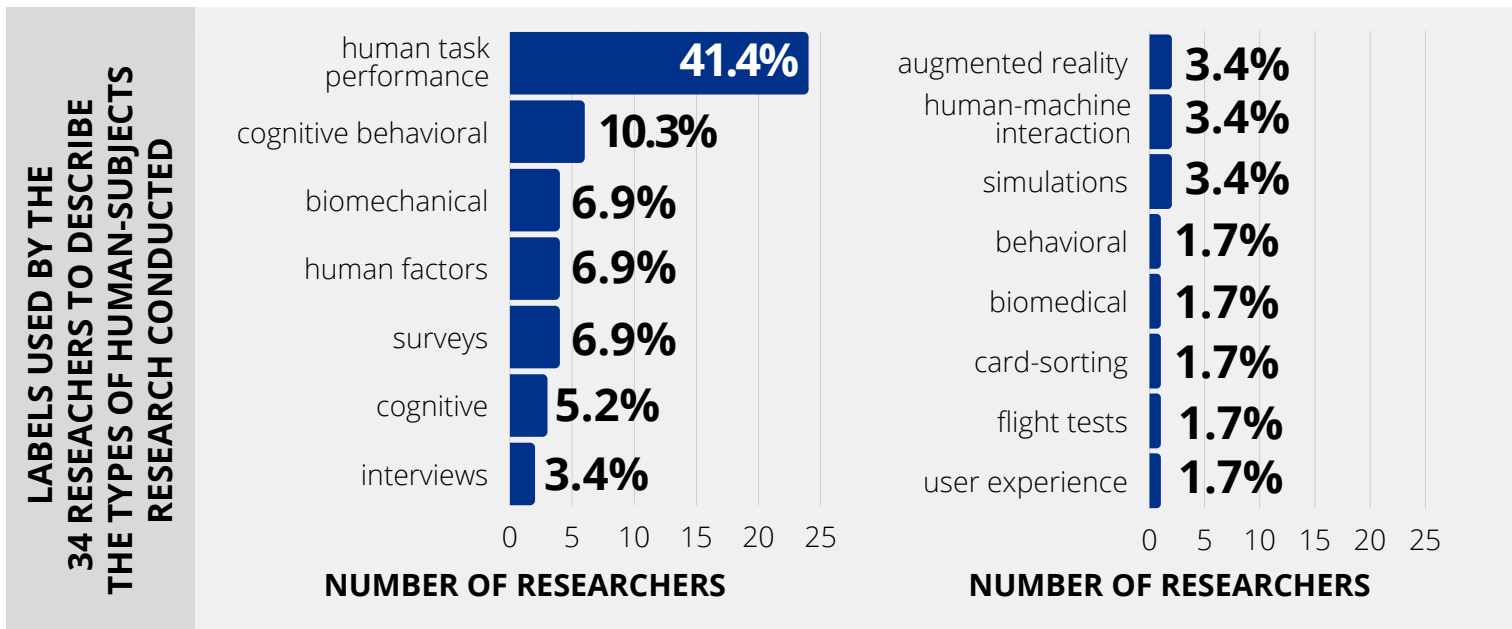
3 We may be able to leverage what we've learned during the pandemic to improve and expand opportunities for human-subjects research.

We can begin to think about which aspects of research don't necessarily have to be done in person which can help reduce commute times for participants and expand the subject pool for researchers.

Methods: The who

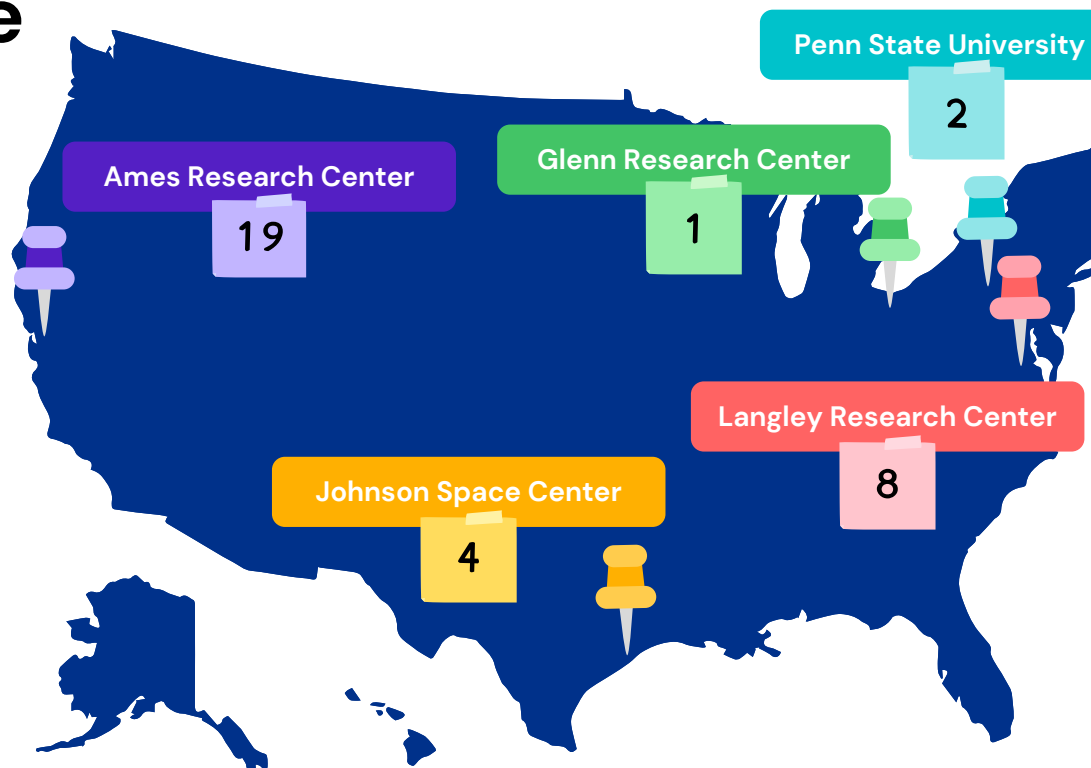
7

Questionnaires and interviews were used to ask **32 NASA researchers** and **2 academic researchers** about their research experiences over the past two years. Below is the data of the self-reported terms used by researchers to describe their type of human-subjects research.



The where

We emailed the online questionnaires and conducted remote interviews to enable researchers all over the country to share their experiences and knowledge gained during the COVID-19 pandemic. The figure to the right maps the locations where the researchers normally conduct their in-person research.



Results and Discussion: The what and the how

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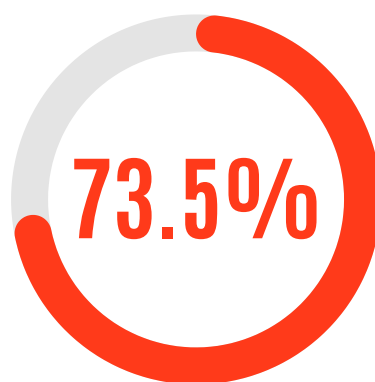
What did we find?

In the year before COVID-19 restrictions were instituted (Spring 2019 - Spring 2020), **73.5%** of the surveyed researchers conducted human-subjects research. The following year after the institution of COVID-19 restrictions (Spring 2020 - Spring 2021), the percentage of researchers conducting human-subjects research dropped to **67.6%**, for an overall decrease of **5.9%**. However, the restrictions did not bring research to a halt, i.e., most researchers who were conducting studies prior to the restrictions continued to do so *during* the restrictions. A complete list of responses to select open-ended questions is provided in the Appendix.

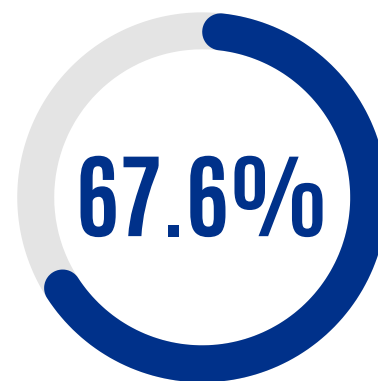
How did researchers adapt; what did they do to continue their research?

% of researchers who conducted human-subjects research studies

Spring 2019 - Spring 2020



Spring 2020 - Spring 2021



58.8% conducted human-subjects studies during the year before **and** the year after the institution of restrictions

17.6% did not conduct human-subjects studies during the year before **OR** the year after the institution of restrictions

14.7% conducted human-subjects studies during the year before but **not** since the institution of restrictions

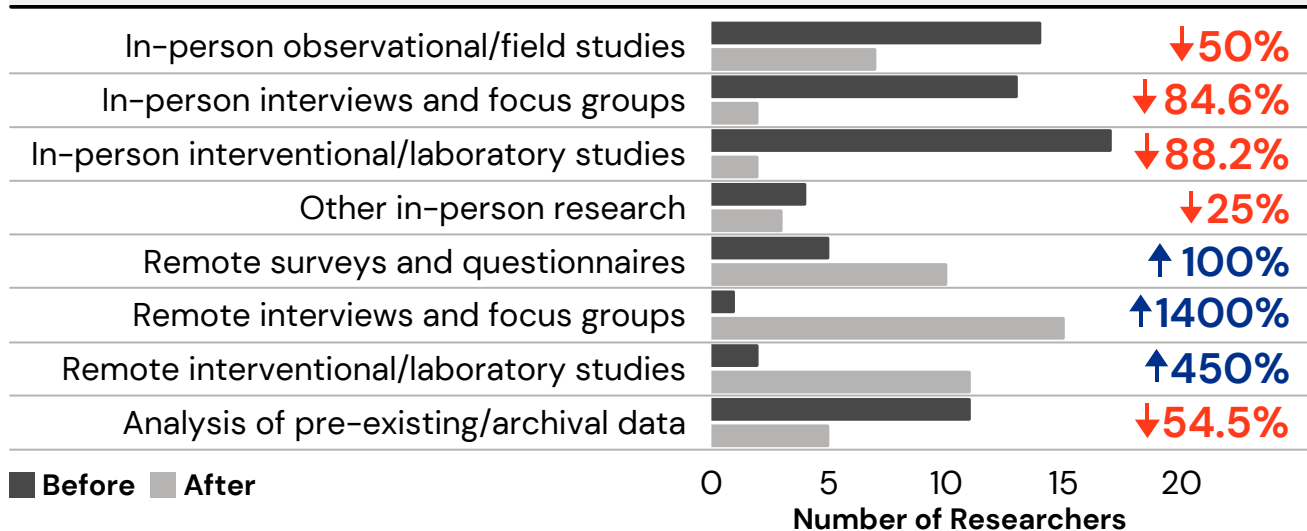
8.8% did not conduct human-subjects studies during the year before but **conducted** some since the institution of restrictions

Results and Discussion:

The what and the how

9

Types of human-subjects studies researchers conducted before and after COVID-19 restrictions were instituted



There were overall **decreases** in all in-person types of studies and overall **increases** in the remote types after restrictions were placed. Additionally, we saw that remote interviews and focus groups were utilized more after restrictions were instituted, which was expected. However, we did not expect to see such a noteworthy increase of **1400%**. A possible explanation for the significant increase could be that, prior to nationwide mandatory telework, participants may not have been entirely comfortable with remote interviews and online focus groups. Video interviews can be artificial and distracting when compared to in-person meetings. Conducting studies in-person is familiar and established with most of the infrastructure and tools set up to support in-person studies. However, under the telework order, researchers tried to use methods with the fewest barriers. Familiarization with remote technologies, as necessitated by the COVID-19 restrictions, actually removed some of those barriers in increasing access and familiarity with remote tools.

Interestingly, the analysis of pre-existing or archival data decreased. Given the considerable increase in remote research, other areas of research may be expected to decrease due to finite bandwidth for researchers to conduct research. Although analysis of pre-existing data was the most common type of remote research conducted before restrictions, other forms of remote research took precedence after restrictions were implemented.

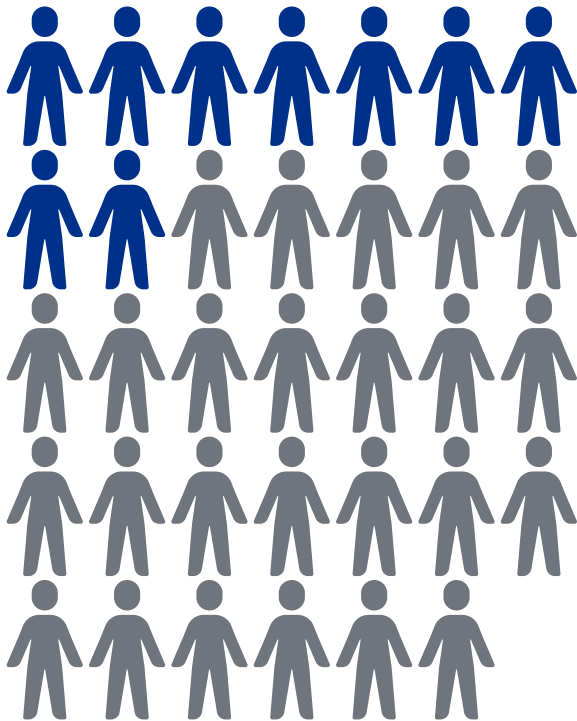
33% Conducted analysis of archival data **before and after** restrictions

58% Conducted analysis of archival data **only before** restrictions

8% Conducted analysis of archival data **only after** restrictions

Results and Discussion: The what and the how

10



26.5% of researchers said that COVID-19 restrictions **did not** affect how they planned and designed their human-subjects studies. Why?

On closer inspection, we found that these **9 researchers** also answered that they did not conduct studies after restrictions were instituted, i.e., restrictions did not affect how these researchers planned and designed their study, because they did not have a study to conduct.

47.1% of researchers said that their experience over the past year did not change the way they think about and plan to conduct research in the future. Why?

After interviewing **5 researchers** out of the 16 who said this, most are hoping for pre-COVID normalcy for their future studies. However, another reported reason was that they had experience conducting studies using similar remote methods in the past and therefore, it was not affected by the restrictions on in-person studies.



Results and Discussion: The what and the how



We asked,

“ To adapt to restrictions on in-person research, have you changed: ”



The majority of researchers had to change the variables they were measuring or manipulating, the participant consideration, the research apparatus used, and the collection protocols to adapt to the restrictions on in-person research. This could be due to the forcing function of the COVID restrictions requiring researchers to change protocols and the apparatus being used, which are the easiest parts to change. Moreover, these changes may have forced a cascade of changes in participant considerations (e.g., no geographical constraint, time-zone factor, etc.), variables, and therefore, the research question. However, we found that the majority of researchers did not have to change their research questions. Perhaps by tweaking the other aspects of the study, researchers were able to fundamentally keep their question the same.

Results and Discussion: The what and the how

13

Challenges of Remote Testing and Possible Solutions

Impacts on what research questions can be asked

Challenges

- Limited ability to observe/collect interpersonal cues
- Reduced engagement with participants may impact data quality
- Participants may not truly experience the desired effects/conditions

Possible Solutions

- Online interactions have become more comfortable/familiar
- Consider series of part-task studies that could be more amenable to limitations of a remote system
- Consider opportunities for new research questions tied to adaptation to remote work

Changes to research questions can be driven by changes in our ability to collect and analyze data. Limiting the data we can collect and analyze can limit the questions we are able to ask. In some cases, researchers may be able to adapt their methods to preserve their research question or break their research question down into multiple sub-questions that could be addressed separately. In other cases, it may be important for researchers to account for how COVID restrictions may have impacted the behaviors or operations they want to study. Thus, using remote testing methods may be highly appropriate for studying behavior and performance for tasks that are, or have become, remote.

Results and Discussion: The what and the how

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Challenges of Remote Testing and Possible Solutions

Logistics considerations

Challenges

- Information Technology (IT) security issues in sending out NASA hardware – there are a lot of steps and paperwork to make hardware and software "NASA-safe"
- Technical support availability

Possible Solutions

- Collect a set of administrative and IT technical barriers that NASA could remove
- Identify IT-approved methods to allow download of low classification simulation software onto non-NASA computers using outside networks to enable distribution of simulations

Different organizations have different IT security considerations, but concerns about shipping of organization-owned hardware to and from people outside of that organization may be a challenge for many groups. An alternative to shipping hardware may be to explore approaches to downloading experiment software onto non-organization hardware for use by those outside the organization. Furthermore, providing IT support for any associated hardware or software issues to those outside the organization may create an unwanted burden. These issues should be carefully considered in collaboration with IT personnel to identify options that may be able to satisfy both research and IT security requirements.

Results and Discussion: The what and the how

15

Challenges of Remote Testing and Possible Solutions

Impacts on data integrity

Challenges

- Transfer of data over limited bandwidth
- Data protection
- Lack of skill or experience in setting up for remote experiments

Possible Solutions

- Use measurement devices or sensors that don't require a technician to set up
- Use self-contained instruments or sensors to capture timestamps
- Provide the participant with the gear or use a third-party platform

Researchers could consider use of “self-contained” or “local to the subject” measurement instruments to ensure collection of accurate timing data and to limit concerns with transfer of data over unsecured networks. Taken to an extreme, researchers might consider providing an entire self-contained experiment to the participant (i.e., an “experiment in a box”). Although such approaches raise logistical and resource challenges.

Results and Discussion: The what and the how

16

Challenges of Remote Testing and Possible Solutions

Impacts on experimental control

Challenges

- Use of variable experimental apparatus (e.g., participants' computers, participants' internet connections)
- Implications for timestamping, data sharing/protection
- Troubleshooting technical problems/participants' ability to accurately use and set-up apparatus
- Less control over participants' environment (e.g. distractions, hardware/software, lighting/other environmental conditions)

Possible Solutions

- Focus on studies high in external validity rather than internal validity
- Measure variability rather than trying to control it
- Increase sample size to accommodate for attrition or mortality and higher levels of performance variation

Experimental control can be compromised as researchers lose the ability to shape the testing environment and systematize the apparatus used for data presentation and collection. This may necessitate increases in sample size to ensure detection of desired effects within higher levels of experimental nuisance variation. Researchers may need to consider changing their study in ways that are less impacted by loss of experimental control, such as focusing on external rather than internal validity, or considering ways to measure or integrate these uncontrolled variables into the study.

Results and Discussion: The what and the how

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What types of studies were researchers able to do remotely?

- 1 Tabletop evaluations and interviews
- 2 Cognitive walk-throughs / talk-aloud / think-aloud paradigms
- 3 2-D images and videos/animations to replace 3-D virtual reality walkthroughs
- 4 Video game-like simulations
- 5 Remote proxy / human liaison

Using this method, the researcher enacts on the system what the participant commands. Researchers have mentioned that this method has had many downsides for their specific study including miscommunications, significant time lag, and dropped signals. Therefore, they were not able to obtain accurate data. However, other researchers may be able to use a similar technique depending on the particular demands and requirements of their study.

What tools did researchers use to remotely complete each stage of their study?

Planning and Development

- Meetings with lab members
 - Zoom
 - Microsoft Teams
 - Cisco Webex
 - Skype
- Remote access to lab machines / systems
 - RealVNC

Piloting

- Surveys
 - Google forms
 - Survey-monkey
 - Microsoft Word
- Interviews
 - Zoom
 - Microsoft Teams
 - Cisco Webex
 - Skype

Data Collection

- Amazon Mechanical Turk
- Remote login for participants to access lab software
 - Virtual machines
 - Apple Research app
 - Other custom web app

Analysis and Writing

- Remote desktop connection
 - Windows application
 - Virtual machine download

Results and Discussion: The what and the how

19

We asked:

How can NASA help?

Researchers responded:

"build competencies within our developer (contractors) and researcher staff about new remote methods."

"be more open to (continuing) remote work, especially in the months prior to an actual study and data collection."

"make software and some hardware accessible to participants."

"set up temporary or permanent locations to allow participants to do simulations."

"find a way to send our tools to people."

"help with logistical hurdles - less paperwork and compensation for remote participants."

"betterment of collaboration tools."

"provide a simulation software that is compatible with and similar to our systems."

Conclusion: The what now?

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Summary

During the COVID-19 pandemic, researchers proved to be resilient and adaptive in finding innovative strategies, approaches, and methods to continue conducting their studies under the mandatory restrictions. Although, as of today, it appears that widespread availability of vaccines may help to bring an end to the epidemic. Over half of the researchers we queried reported that their experiences during the pandemic will change the way they think about and conduct research in the future. Additionally, remote study techniques help widen the participant pool, do not require participants to travel or commute to centers, and can often be cost-effective for the researcher and participant.

Depending on the study and the variables being measured, a hybrid remote and in-person strategy may be ideal for some studies. Researchers were able to efficiently execute the early and late phases of a study, such as development and planning, some parts of the piloting phase, and analysis and writing, remotely with no major issues. However, although many researchers were able to adapt existing methods - and even invent novel methods - to remotely collect data for their specific study, they faced many challenges including the validity of the data, technical issues on both sides - participant and investigator, and inability to control a participants' remote/home environment.

There may be advantages to conducting parts of a human-subjects study remotely, especially now that people are more open to and comfortable with online interactions. It may be beneficial in the long run, and in the future, to continue being creative and finding innovative approaches that outweigh the learned disadvantages of remote work. As researchers continue to innovate and adapt to changing research conditions, organizations should work to capture and share the lessons that are learned.

Ideas for Future Work

- Given familiarization with both remote and in-person capabilities, what will or should researchers do remotely vs. in-person moving forward?
- Can the effects and impacts of the COVID-19 restrictions on human-subjects research be seen in journal submissions?
- What are the psychological and social effects of social distancing and remote work on human-subjects research?

References

21

1. Marhefka, Stephanie et al. "Achieve Research Continuity During Social Distancing by Rapidly Implementing Individual and Group Videoconferencing with Participants: Key Considerations, Best Practices, and Protocols." *AIDS and behavior* vol. 24,7 (2020): 1983-1989. doi:10.1007/s10461-020-02837-x
2. Lumeng, Julie C et al. "Opinion: A risk-benefit framework for human research during the COVID-19 pandemic." *Proceedings of the National Academy of Sciences of the United States of America* vol. 117,45 (2020): 27749-27753. doi:10.1073/pnas.2020507117
3. Townsend, Ellen et al. "Key ethical questions for research during the COVID-19 pandemic." *The lancet. Psychiatry* vol. 7,5 (2020): 381-383. doi:10.1016/S2215-0366(20)30150-4
4. Sayed, Ahmed M., "A New Method for Biomechanical Data Acquisition in Remote Laboratory Delivery During the COVID-19 Pandemic" (2020). ASEE North Midwest Section Annual Conference 2020 Publications. 4.
5. https://openprairie.sdstate.edu/asee_nmws_2020_pubs/4
6. Padala, Prasad R et al. "Conducting Clinical Research During the COVID-19 Pandemic: Investigator and Participant Perspectives." *JMIR public health and surveillance* vol. 6,2 e18887. 6 Apr. 2020, doi:10.2196/18887
7. Lupton, D. (editor) (2020) Doing fieldwork in a pandemic (crowd-sourced document). Available at: <https://docs.google.com/document/d/1cIGjGABB2h2qbduTgfqribHmog9B6P0NvMgVuiHZCl8/edit?ts=5e88ae0a#>
8. Wigginton, N S et al. "Moving academic research forward during COVID-19." *Science (New York, N.Y.)* vol. 368,6496 (2020): 1190-1192. doi:10.1126/science.abc5599
9. Elmer, S. J., & Durocher, J. J. (2020). Moving student research forward during the COVID-19 pandemic. *Advances in physiology education*, 44(4), 741-743. <http://doi.org/10.1152/advan.00153.2020>
10. Lobe, Bojana, et al. "Qualitative Data Collection in an Era of Social Distancing." *International Journal of Qualitative Methods*, Jan. 2020, doi:10.1177/1609406920937875.
11. Fernandez Lynch, Holly et al. "Regulatory flexibility for COVID-19 research." *Journal of law and the biosciences* vol. 7,1 Isaa057. 7 Jul. 2020, doi:10.1093/jlb/Isaa057
12. Radecki, Jane, and Roger C. Schonfeld. "The Impacts of COVID-19 on the Research Enterprise: A Landscape Review." *Ithaka S+R*. Ithaka S+R. 26 October 2020. Web. 19 May 2021. <https://doi.org/10.18665/sr.314247>
13. <https://www.cdc.gov/coronavirus/2019-ncov/your-health/about-covid-19.html>
14. <https://www.wsj.com/articles/in-hunt-for-covid-19-origin-patient-zero-points-to-second-wuhan-market-11614335404>
15. <https://www.who.int/director-general/speeches/detail/who-director-general-s-opening-remarks-at-the-media-briefing-on-covid-19---11-march-2020>
16. <https://www.nasa.gov/press-release/nasa-administrator-march-17-statement-on-agency-response-to-coronavirus>
17. <https://nasapeople.nasa.gov/coronavirus/rtow.html>
18. <https://roundupreads.jsc.nasa.gov/pages.ashx/1677/Johnson%20Goes%20to%20Stage%20%20Wednesday%20April%2028>
19. <https://www.cdc.gov/coronavirus/2019-ncov/vaccines/fully-vaccinated.html>
20. <https://nasapeople.nasa.gov/coronavirus/coronavirus.htm>
21. Myers, Kyle R et al. "Unequal effects of the COVID-19 pandemic on scientists." *Nature human behaviour* vol. 4,9 (2020): 880-883. doi:10.1038/s41562-020-0921-y
22. <https://www.cdc.gov/coronavirus/2019-ncov/vaccines/effectiveness/work.html>

Appendix

22

Individual responses to selected to open-ended questions.

Note: all references to specific individuals, labs, and locations have been removed.

Prior to COVID-19 restrictions, what type of data did you collect, i.e., what metrics did you use to measure and answer your research question?

- Workload (NASA TLX); Response times; response accuracy; situational awareness (SART); psychophysiological data (eye tracking); task completion
- scales, questions, surveys with descriptive analysis and simple statistical analysis where possible
- Objective: accuracy, RT. Subjective: ratings
- Subjective acceptability, response time, subjective workload
- error, time on task, workload, SA, trust, usability
- efficiency metrics in terms of increased traffic throughput, reduction of delays, etc.; feasibility metrics in terms of controller workload, subjective feasibility ratings, etc.
- response time, performance, workload, situation awareness
- multiple: experiment-based performance on complex cognitive tasks, such as operating simulated equipment, providing explanations, and various assessments. So, mostly things like percent correct, and qualitative scoring of responses.
- Motion data, ground reaction force, EMG.
- Response time data, objective performance data (e.g., mission success), subjective ratings of performance and workload, opinions and feedback on displays and interfaces
- rating scales, individual survey questions (qualitative), interviews, observations, counts, mouse clicks. usually looking for workload, SA and workflow confirmations
- We use acoustic metrics to quantify noise exposure and our survey uses an ordinal scale related to noise annoyance
- Video, audio, surveys on paper, laptop, or iPad. Data collected through Morae, custom software, eye tracking.
- human performance data (e.g., response time, response accuracy), questionnaire data (e.g., workload, trust, situation awareness)
- objective performance - response times, accuracy, ability to complete the task; subjective performance - workload ratings, usability ratings, acceptability ratings
- cognitive tests, physiological sensor data
- Qualitative usability assessments, quantitative human error analysis and task saturation metrics
- RT, correct procedures, errors, mission success
- Reaction times, compliance with directive alerting, SA, workload, subjective opinions on interface and system design
- Cognitive behavioral, task performance
- Data: eye movements, human-in-the-loop simulation data, questionnaires, interviews. Metrics (high level): sensorimotor control, workload, pilot performance.
- workload, situation awareness, usability, usefulness, ...
- Workload, time on task, subjective acceptability
- in-person observational/field studies, surveys and questionnaires, behavioral and psychophysiological monitoring
- Questionnaire response data regarding Situation Awareness, Workload and Usability
- performance metrics such as time on trial interview data
- Cooper-Harper Handling Qualities rating scale, Bedford Workload Scale, NASA TLX, SUS, Borg-CR 10, time on task, error frequency and error rate, subjective comments, and observational notes
- in my lab, we collect human performance data during EVA, simulated EVA, exercise, and injury surveillance
- that depended on the study. response type; response time; response accuracy; survey questionnaires; eye tracking; aircraft performance...
- Objective data such as response time, accuracy, vehicle attitude, noise generated, and option chosen. Subjective data such as preferences, workload, recall data, and cooper-harper ratings
- system requirements (information content, arrangement, workflow, timing); HITL metrics (flightpath error, response times, eyetracking metrics(detection time, scan path, dwell time)); prototype evaluations (scoring on multiattribute criteria, pairwise comparison preferences - AHP analysis)
- Used cognitive task analyses questionnaires to answer our research questions.
- Surveys, behavioral data, decision making data.
- Tended to do a significant number of subjects, e.g 24, taking performance metrics (e.g. max deviation from glideslope and localizer approach course per landing approach), then doing parametric statistics to see if different cockpit systems had significant impact on performance.

Appendix

23

Individual responses to selected to open-ended questions.

Note: all references to specific individuals, labs, and locations have been removed.

What considerations and/or barriers contributed to not conducting any human-subjects under COVID-19 restrictions?

- It is difficult to have users work through tasks when they are remote.
- In ability to conduct onsite subjects and testing
- Primarily project related reasons - 2020 was primarily a planning year.
- The study we were performing in 2019 ended and we didn't have any human-subject testing lined up for 2020.
- Our work did not require any human-subject testing at this time
- The Human Factors Engineering Lab is made up of 3 very small rooms, a control room, an observation room, and an overflow room. The restrictions to keep people 6 ft apart or more meant that only 1 - 3 people could be in the rooms at any time.
- Previous projects ended. Current projects in early development stages and not ready for human-subjects research. Plans are in place to resume such research in the near future.
- No opportunity due to project-related goals. Our tests were mostly technical in nature and did not require human subjects.
- I didn't have any funding to conduct such research.
- Need to use a simulator
- n/a - project work did not sponsor human-subject work during this time.

How did you change the research questions you were asking to adapt to the restrictions on in-person research?

- we are asking simpler research questions since our remote participation requires a simplified task environment;
- Due to in-person human-subjects testing, we were unable to answer the specific questions of interest that require a human to interact with a system in an operational or laboratory environment. We pivoted to try and measure differences from previous well-studied findings (e.g., automation reliability positively correlates with trust) to remote-data collection environments (e.g., Amazon's MTurk) - we did this to investigate if it was even a good idea to study current questions of interest in a remote-data collection environment.
- The experiment design was no longer comparative so the research questions changed to be more open ended.
- Generally, I have not conducted human subject research since COVID-19 because the work I am doing focuses on a dynamic display and learning to fly certain ways. Not being able to use a simulator makes any experimentation very difficult to do. 1. Looking to do more surveys or storyboarding so research questions have to be formed around the method therefore I may be missing comments containing rich information. Furthermore, directions and tasks must be very well defined because I may not be able to answer questions in time. Also need to account for internet accessibility and stability.

How did you change the variables you were measuring and/or manipulating to adapt to the restrictions on in-person research?

- Due to cybersecurity protocols, participants were not able to remotely have access to our simulator equipment. Instead, we established a researcher role known as the subject-surrogate, who implemented actions on the participants' behalf. This changed how the system was being manipulated (through the surrogate under instruction of the participant) as well as introduced other surrogate-related metrics (e.g., surrogate workload, latency/lag times between remote staff and subjects).
- cannot really look at workload or SA, focusing more on workflow and look and feel of interfaces at the moment;
- Cannot measure error rates via keystroke logging.
- we are required to rely more heavily on subjective performance than objective performance since their objective performance is heavily impacted by the remote nature of their participation;
- How we measure has changed. For instance, due to the remote nature of our HITL study, we had to have a liaison researcher in the loop to input commands to the ground control station which to our detriment impacted our time-based data.
- Generally, we would like to have a participant interact with an unreliable form of automation and measure their trust during and following the interaction. For the remote-data collection activity (via MTurk), we simply had participants watch videos of an unreliable system - they could not interact with it in any meaningful way.
- Reduced the number of psychophysiological sensors included in study;
- Need to ensure surveys are not too long so people will complete it which limits the number of variables and the steps within those variables
- we are not asking scales as much, questions in interviews are more general and less specific.

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Individual responses to selected to open-ended questions.

Note: all references to specific individuals, labs, and locations have been removed.

How did you change the participant considerations ((e.g., study population, recruitment methods, criteria for inclusion/exclusion, use of within-/between-subject designs) to adapt to the restrictions on in-person research?

- Introduced COVID protocols for subject recruitment (e.g., COVID test within 48 hours of testing, etc.)
- have used members of the group as first participants, i.e., really reduced finding participants
- Used friends/family/co-workers versus the test subject selection database or JSC roundup newsletter
- we needed to be more cognizant of participant's at-home equipment to minimize the risk of poor internet or poor screen resolution;
- We did perform some interviews with subject matter experts, but did not have them complete any studies - all experiments were conducted sampling the MTurk population. We did not attempt to conduct any within-subjects experiments, due to the technical difficulties associated with that type of design.
- Required test subjects to consent to COVID-19 testing, which some test subject declined so they were not recruited to participate;
- Have included COVID related questions to screen out exposed/infected persons.
- With surveys, can obtain more data than when using simulators so prefer to use a larger subject pool. That pool then tends to be more inclusionary.
- we have relaxed our participant requirements and asked team members to be pilot/dry-run participants.
- Currently planning human subject research in late 2021, with the uncertainty surrounding covid our team has had to consider alternatives to bringing subjects into the lab to collect data including recording scenarios and interviewing subjects. This would change the scope, measures collected and where we conduct the research
- The limitation of the subject recruitment led to a simpler search for the participants rather than casting a wide net.

How did you change the research apparatus, equipment, and materials you were using to adapt to the restrictions on in-person research?

- Used an off-Center simulation facility, because access to on-Center facilities was restricted.
- We created the new researcher role of the subject-surrogate and carried out the simulation using Microsoft Teams.
- cannot use the lab equipment.have worked out a way for researchers to use the computers at home and are sharing information over Teams.
- Online methods such as Teams or Zoom vs. in-person
- Instead of purpose-built cockpit simulator mockup, have to use Microsoft TEAMS on standard desktop display
- subjects had to have internet and appropriate computers/screens
- we were unable to allow the participant to directly interact with our interfaces so had to rely on them responding verbally to what they were seeing via screen sharing from our researchers;
- We used the same hardware for the remote HITL, but we used Teams to share the live displays.
- We exclusively used MTurk to collect data - generally, we would use MTurk as more of a pilot test for an experimental concept, not as the main (only) place to conduct human-subjects research.
- Used an off-Center simulation facility;
- Mostly relates to how to sanitize the equipment/suits. Also limited the availability of Air Force lab facilities
- Using "paper and pencil" (or computer screen) rather than simulators. I have not found a satisfactory way to have the displays change in real time depending on the subject's input.
- we have had to use teams and have not been able to use our lab set up.

How did you change data collection protocols/procedures to adapt to the restrictions on in-person research?

- Limited on-site team as much as possible; everyone wore personal protective equipment; simulator was sanitized between subjects; frequent breaks from the simulator was included; post-simulation interviews were conducted remotely to limit exposure between experiments and participants.
- We created a verbal communication protocol for both the subject and surrogate to convey and implement actions in a standardized way.
- have not been able to train participants to the same level (feeds back into 2 & 3 above), so have not been able to ask such in depth questions

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Individual responses to selected to open-ended questions.

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- Watched participants over virtual meetings and asked questions or provided online surveys, vs in-person observation and paper survey
- certain data is unable to be collected during remote cockpit usability evaluations.
- we used a surrogate at the exp station who commicated via team with the subject - had to develop portocols, grammer, etc.
- the big difference is that the participant could only interact verbally with our researchers and the researcher would interact with the displays according to the participant's requests.
- We had to implement our HITL study remotely. This was a challenge due to security restrictions.
- We conducted the MTurk studies as we usually would. However, we would usually conduct studies in laboratory or operational settings.
- Incorporated remote interview approach to debriefing sessions with test subjects to permit longer question and answer sessions
- Have included remote observation via Teams/WebEx for non-essential test personnel (for additional note taking, observation, etc) and stakeholders.
- Same as above. Changed procedures to account for COVID precautions and subject safety
- I am not necessarily there when the subject completes the test;
- We had to use MS Teams for the interview sessions and showed pre-recorded simulation scenarios that we still had to go into the lab in person to develop.
- We had to change from simulation studies to focus group knowledge elicitation and cognitive walkthrough of pre-canned use cases. The data collection were interview questions and remote surveys / questionnaires instead of objective metrics.
- data collection had to be redesigned to account for remote work
- We typically conduct cognitive task analysis interviews in-person and conduct observations of participants in their work space; however, due to COVID-19 restrictions, we are unable to conduct the in-person observations and interviews. However, with the use of NASA-approved video chat platforms like Cisco WebEx and MS Teams, we are able to conduct the interviews virtually and have the cameras on as a workaround for not being able to conduct the interviews in person.
- For remote simulation, the system we were using could not be directly accessed and controlled by a participant due to NASA IT security policy. Instead, we had a role known as the "researcher liaison" whose screen was shared with the participants over Microsoft Teams. The researcher liaison would execute commands from the participants to interact with the system. This required us to develop a robust verbal protocol that also allowed for some flexibility in unique or unexpected situations. This also changes how we look at the response times that we would normally collect since there is an artificial inflation from having an extra individual in the loop performing the commands for the participant.
- In a remote environment, reaction time is a less accurate measure and so we're focusing more on decision making and over assessment of the display and procedures. In the most recent study, the participants told the researcher what actions they would take in a given situation and the researcher manipulated the display. Participants could only view the simulation remotely and not directly interact with the simulation environment

What new insights, lessons, adaptations, or methods employed under COVID-19 restrictions are you planning to continue or carry forward if/when restrictions on in-person research are lifted?

- Sanitation procedures will likely remain in place.
- improved our robustness for remote testing it takes significantly longer to collect data
- We had to think about running some studies remotely online, so now we have more options to run different types of studies. On the other hand, we run a complex, distributed simulation studies that work the best when multiple participants work collaboratively in a simulated world, which cannot be replicated online, so we also need to get back to normal as soon as possible so that we can gather rich data that we were able to collect before.
- This is a tough one. Remote data collection has enabled us to continue with research but it has been less than ideal. When restrictions lift, we need pilots back on actual simulators.
- We can probably carry out more tabletop studies, cognitive walkthroughs, and cognitive task analyses which lend themselves better to remote execution and participation.
- Once a participant has been introduced to our tools in the lab, i can see running follow up interviews with them over Teams. But the restrictions have underlined to us the importance of bringing participants in to the lab to introduce them to our tools
- Increased work from home during the pandemic may mean more people working from home in the future, during anticipated community response studies

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Individual responses to selected to open-ended questions.

Note: all references to specific individuals, labs, and locations have been removed.

- The innovative methods for virtual testing instead of in-lab testing has made our lab more mobile.
- Discovered ability to obtain most of our usability metrics via remote cockpit usability analysis
- Will use remote control of systems/interfaces that are located physically in lab possibly for development off-site
- Figuring out a way to allow a participant to control a simulation from a NASA-based system remotely.
- We've learned that there is quite a bit that can be done remotely, so there will likely be greater use of that approach in early research stages. At some point, though, I do still feel that in-person testing is needed.
- The use of remote interview approach to debriefing sessions with test subjects to permit longer question and answer sessions seems to be applicable and beneficial for future studies.
- Remote viewing capabilities are a great way to include personnel without incurring extra travel costs or crowding the testing site with non-essential personnel.
- I haven't had the need/sponsorship to do this type of work in the COVID period; but it has made me think about approaches to presenting concepts online and conducting knowledge elicitation through teleconferences; the value that quick surveys have for converging to solutions/features. We, NASA, need to get it figured out with the paperwork reduction act constraint on ability to conduct surveys.
- Although conducting virtual interviews is not ideal for cognitive task analyses, it does create a more flexible method for carrying out the experiment as it allows for flexibility with time (no need for travel) and also allows us to conduct interviews with more individuals from across the country without having to plan around travel plans or constraints related to travel.
- I have reconsidered whether or not I want to continue conducting human subject studies.
- Well, now that I've setup an eye tracker, and learned how to do these data-modeling-intensive analysis methods, may continue with them some more!

What did you find to be the biggest challenge(s) to adapting your research activities under COVID-19 restrictions?

- Finding a remote (off-Center) location to conduct research; training the limited number of on-site team members to perform functions normally performed by a larger team; ensuring compliance with COVID protocols to meet Center and IRB requirements.
- we still have them - getting users physically with the tools we build
- the need for unique on-site facilities
- Determining how to get the same level of generalizability and validity with remote methods that you would in-person
- hardware limitations -- it is very difficult to ensure everyone is using the same hardware.
- The biggest challenge was accessing lab systems remotely. In order to follow IT security plans, few people are allowed remote access, which is why participants were not allowed to directly connect to our systems but instead had to have a researcher connect.
- As I said above, we cannot run the type of studies online that we normally run remotely. If the Covid-19 life were to be permanent, we would need to invest heavily in creating a safe, fast, secure internet network that we could use for our distributed simulation platform outside of NASA firewall that we couldn't develop in the current climate where everyone is expecting for the remote life to be a temporary condition. If we could develop a distributed network backbone that can work outside of NASA firewall and is fast, we can re-create our simulation environment, completely remotely. Additional issues exist in sending NASA computers that have pre-loaded sim software to the participants, which also would need to be figured out. If we invested in such capability, a whole new avenue would open up for us to run a new type of simulation studies.
- actually, probably reduced and higher overhead communication with colleagues.
- I didn't have any studies going on, so I didn't have to adapt. If I did, I probably would have applied for RTOW status in order to be able to complete the study, or I would have thought about if there was a way to perform the study remotely. Perhaps using the Kinect technology more, or video camera based solutions. I would have also explored the ability to use computational modeling instead of actual motion data.
- Security and bureaucratic hurdles/barriers. While they are challenges, most of these barriers are understandable and reasonable.
- inability to access the lab. Teams provides a small area on which to provide information so you can only introduce a little information at a time
- none
- Find the right technology to fit needs and being able to use that technology at NASA. Also, protecting PII.
- inability of on-site subjects
- IT security policies

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Individual responses to selected to open-ended questions.

Note: all references to specific individuals, labs, and locations have been removed.

- Planning: The biggest challenge of the COVID-19 restriction was not knowing when/if we would be getting back to the lab. At the beginning of the pandemic, I was planning studies in preparation for a return to on-center work. This was largely a waste of time, as resources and circumstances have evolved and changed the types of studies we were planning to conduct in person - we ended up focusing all of our attention to software development.
- Getting consistent interaction between participants since their at-home environment could heavily influence their impression of the interfaces (e.g., distracted by others in their home, small screen, bad internet connection, etc.)
- We need to interact with participants to do sleep deprivation studies.
- Lack of personal connection to study participants; unable to see body language of participants, for example.
- Using remote access and teleconferencing tools, specifically in ways that they were not originally intended. Fighting with internet bandwidth.
- Security restrictions. Having to use a researcher liaison to input the GCS commands. Also limiting the number of research personnel that could use the GCS remotely.
- Differences in internet connectivity in terms of bandwidth, strength, length, and latencies. At times it's very difficult to even show a video or live screen share of an interface due to its choppiness. I think it's getting better over time, though.
- Getting physical access to facilities. The amount of paperwork was enormous to get on-site and conduct tests.
- Uncertainty of requirements from oversight entities (local approvers, IRB, partner approval panels). The situation related to COVID-19 pandemic is dynamic and it is difficult for consistent requirements to remain stable and predictable.
- The primary challenge has been the lack of face to face meetings with collaborators and this may have delayed the development of a Table Top exercise with subject matter experts to learn more about their user acceptance of Air Taxis as new entrants in the National Airspace. Although the delay might have occurred due to organizational politics or for other reasons.
- Remote interviewing can be difficult due to a barrier between you and the participant. Longer intro time is needed for comfort. Adapting the technology to suit remote lab studies was also a challenge
- Travel. Number of personnel allowed in a single room or space.
- Travel restrictions, Air Force lab availability
- Inability to easily talk with participants
- Adapting our research activities was not challenging since we have access to these video chat platforms. However, some challenges that do come with conducting virtual interviews is that the you cannot have a "controlled" environment without distractions for the participant since it's not being conducted in a lab or a conference room. Additionally, there are technology glitches either with the sound or video due to connectivity issues, but these challenges are mild.
- The bureaucracy. The arbitrary and often non-nonsensical rules.
- Delay of months where we were told we couldn't bring in anyone. * All sorts of logistical hurdles that required more administrative overhead, scheduling into limited hours allowed into building, needing to do COVID screening, etc.* I think some pilots were apprehensive about coming in until we started being vaccinated, particularly for something where they were mostly volunteering their time * Difficulty in running study -- wanted graduate student there with pilot but grad student isn't expert on sim or piloting, so I learned how to supervise simulator runs and answer pilot questions via Zoom.
- although i understand the need for security protocols to keep NASA data safe, these have worked against us during the pandemic. Right now we are unable to send equipment to people for them to trial at home (& for us to collect data).
- I think a big part of it was also recognizing that we wouldn't make our contract deliverables and student wouldn't graduate unless they relaxed initial injunctions setup during first lockdown -- if we had stayed at that level, we never would have completed! And, I don't know how we could do this research without humans-as-subjects testing, highlighted that there are limits on how much we can do out of the lab.

Describe any positive insights, opportunities, or impacts you identified from adapting your research activities under COVID-19 restrictions.

- Almost universal familiarity with remote connection technologies (e.g., Zoom, Teams, etc.) will facilitate use of these technologies for certain types of data collection (e.g., interviews)
- the project pace slowed down for a little while
- My team has adapted online collaborative tools which facilitates working on the same task
- aside from making our data collection software more robust, everything about conducting research remotely isn't fun

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Individual responses to selected to open-ended questions.

Note: all references to specific individuals, labs, and locations have been removed.

- In the future, hybrid working condition - i.e. going into the office part-time and working home the other times - would be ideal for many people and would really help alleviate the commute and the traffic jam in the Bay Area. I found that most meetings can be done remotely but some meetings would benefit a great deal by doing it in person once everything goes back to normal. I should work from the office some of the times so that people could drop in and ask for advice, discuss topics, etc. but otherwise, I can focus on my work better without office interruptions when I am at home.
- A positive impact is seeing the adaptability of the team and field and the support of the Administration.
- remote contact is proportionately easier
- Having subjects come to the lab, don motion markers and perform tasks/exercises is a bit clunky, it might be better all around to find a way to streamline the motion capture process with the use of less obtrusive methods.
- The design, planning, and development tasks can largely be performed remotely.
- Have spent more time developing capabilities before running a study, so tools are more developed on first presentation
- none
- Now we know we have the option of testing participants on-line vs asking them to come into the lab or us having to go to them!
- I realized that MTurk is an effective, low-risk method to test research concepts before planning a larger/expensive studies. We will likely keep MTurk as a stage in our research process.
- A lot more development can be done from home than we expected; data collection (for our needs) was very difficult but development in the future could rely on more work being done from home
- I'm not sure there is anything that is particularly positive. It's much harder to do research with work-arounds.
- Ease in scheduling participants since they could take part even while on TDY
- insight into virtual comm protocols
- Ability to meet fiscal year milestones, able to utilize time still to better understand how to redesign interface elements before running an in-person simulation in the future
- The possibility of getting things done, that were traditionally accomplished in an in-person environment, from anywhere in the world
- A large proportion of work can be done remotely. I think we were more efficient in some tasks (e.g., data analysis, brainstorming), and slower in others (e.g., HITL development, HITL execution).
- It was beneficial in exploring just how much could be accomplished remotely in terms of planning, development, and testing.
- In some cases, staying at home while running tests remotely can be more comfortable for researchers. It eliminates commute time and makes work hours more flexible.
- The ability to run less complex studies is supported in the current environment which does relieve the pressure typically associated with conducting HITL studies.
- The primary insight has been that a great deal of communicating with collaborators and development work can be accomplished under remote work conditions. The main concern was if we were able to conduct interviews with subject matter experts, would we lose any information from not being able to collect non-verbal clues such as body language and facial expressions.
- studies can be done remotely, and can save lots of money on travel costs
- Remote viewing capabilities are a great way to include personnel without incurring extra travel costs or crowding the testing site with non-essential personnel.
- I have done some studies over the web already 25 years ago. with today's technologies, it's possible to do a lot remotely.
- Having virtual experiments opens the door for more "quick" research efforts, including mini-focus groups, working group meeting sessions, etc. that would not be as simple when conducted in-person. The ability to connect with folks across the country via video chat platforms allows for much more flexibility. Even though there are some cons, the pros are worth exploring and using in future studies that are similar in nature.
- As noted above, now that I've setup an eye tracker, and learned how to do these data-modeling-intensive analysis methods, may continue with them some more!
- I thought that COVID would affect conferences and publications, but that's not the case. in fact im publishing more due to the reduced conference fees and no travel
- We are currently looking into conducting a mini human-in-the-loop experiment as a follow-on study to our cognitive task analysis research effort. The follow-on study would be using one of the simulators on Center, but due to COVID-19 restrictions it is not simple to just go on Center and test things out on the simulation. However, our Branch has wonderful resources by allowing us to access parts of the simulation on the Cloud, which is helpful for planning purposes. We are still looking into ways of further planning for this follow-on study without the risk of bringing in researchers and contractors on-site (until it's absolutely necessary).

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13. SUPPLEMENTARY NOTES

14. ABSTRACT
The goal of this effort was to identify innovative strategies, approaches, and methods that have enabled researchers to continue doing meaningful human subjects research during the COVID-19 pandemic. Many organizations and recent literature primarily focus on efforts for future research in a post-COVID environment. Additionally, there have been no systematic efforts across the agency or broader human factors community to coordinate or share strategies. Therefore, the focus was on acquiring knowledge gained by researchers from experiences during COVID that could be valuable to continue human-subjects research under existing restrictions.

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