The 'All-Day Mirror': Exploring the Influence of Self-View in a Videoconferencing Setting.

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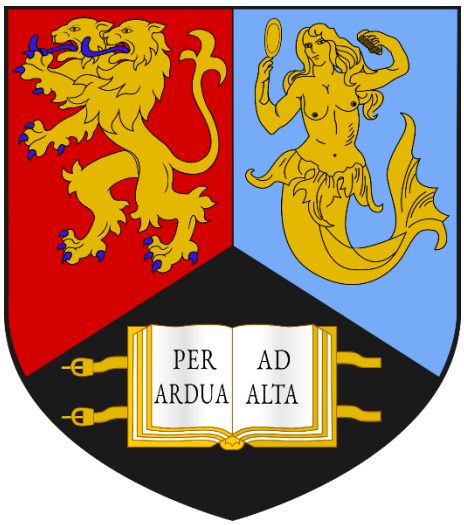
September 2021



A dissertation submitted in partial fulfilment of the requirements for the degree of MSc Human-Computer Interaction at the University of Birmingham.

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Abstract

The primary aim of this project is to investigate whether there is an attentional difference in groups who have their webcam switched on in comparison to those who have it switched off in a videoconferencing setting. It also aims to assess whether there are any other relevant extraneous factors which may contribute to varying levels of attention in videoconferencing settings, and to add to the literature regarding specific components of videoconferencing, such as use of webcams. The primary issue recognised in this experiment is the fact that virtual meetings do not adequately replicate the human dynamics of in-person meetings, which is evident from the significant figures of mental health complications, biases towards in-person workers, meeting fatigue due to over-stimulation and overuse of mental resources, among others. To commence investigating the beginning of a new, natural, and comfortable method of videoconferencing, this experiment focuses specifically on the effects of the webcam. In this experiment, 58 individuals participated in a 10-minute pre-recorded meeting about the future of work and education after the COVID-19 pandemic is over. Change blindness was used to assess attention levels throughout this meeting and, as a result, the backgrounds, outfits, and names of the actors were changed, and participant recall of these were assessed with participants split into conditions based on whether they had their webcam on or off. A significant difference was identified between those who had their webcam on or off in regard to how many backgrounds they correctly identified from participating in the experiment. A further significant difference was found between the webcam conditions and the number of 'actor one' backgrounds recalled. A significant correlation was found between the number of backgrounds correctly identified and the time of day the experiment was completed at, as well as a correlation between how interesting participants found the meeting and how difficult they found it to concentrate on the meeting. These results have implications for the future of videoconferencing and prompt the need for further examination if these components are to be improved in the future.

Key Words

KW: videoconferencing; self-view; change blindness; webcam.

Acknowledgements

I would like to thank my wonderful family for their unwavering support and guidance throughout this intense year; the same support that has remained constant throughout all my years in education and has acted my greatest motivation for success.

I would also like to thank my supervisor, Professor Russell Beale, whose expertise was invaluable in developing my research topic to the best of its ability.

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1. INTRODUCTION

The primary aim of this report is to investigate, in a videoconferencing setting, whether there is an attentional difference in groups who have their webcam switched on in comparison to those who have their webcam switched off. A secondary aim of this report is to explore any additional components and extraneous factors during a videoconferencing context which could impact attentional differences further. This report will put these findings into the context of, and develop on previous literature regarding, videoconferencing meetings with an overarching goal to help to improve the future of videoconferencing.

After the declaration of COVID-19 to be a pandemic in March 2020 [7], previous methods of working and studying were forced into a rapid and complete remodelling. This global and once in a lifetime experience has found millions of people either unable to work or having to change their mode of work to an exclusively or hybrid remote setting. In December 2019, Zoom had 10 million daily meeting participants and by April 2020, there were more than 300 million [10]. This sheer increase is an indication that in-person work will never be the same and that a new, hybrid system must be examined and developed.

1.1. The Future of Work and Education

This widespread change in mode of work has been anticipated for many years [33], but a gradual transition was upended by the sudden nature of the COVID-19 pandemic. The height of the pandemic found office workers and students working exclusively remotely. As places of work and education begin to open back up, it is predicted that many establishments will shift to a mixed mode of working encompassing a both remote and in-person hybrid system [20]. Global research and advisory firm Gartner predict that, by 2024, only 25% of their business meetings will take place in-person [27]. This transition has been mirrored by several different companies such as Amazon, Microsoft and Coinbase, among others [6]. Capital One, for example, are adopting a 'flexible hybrid model' that will allow employees to work remotely when they see fit [6]. There is not an exhaustive literature on the framework of videoconferencing, and this rapid workplace evolution means that it's details require further research.

There are several advances this evolution could provide to workplaces and their employees. In terms of companies, there is a lot of money to be saved on lease agreements, as well as having access to a massively broad range of employees instead of a limited few in defined areas. Dell recently published a report [16] displaying an annual saving of 12 million dollars after reducing their number of lease agreements during the height of COVID-19. In the same report, they illustrate a benefit for employees, where they estimated an annual saving of 350 dollars per year for employees who work remotely only 33% of the time. Employee time saved by working remotely could lead to better rested individuals, which could increase attention, retention, and therefore overall productivity [13]. Nevertheless, these are merely predictions since attentional differences and difficulties have been sparsely investigated in videoconferencing settings. Therefore, this report aims to fill this gap in literature and develop the current knowledge.

Despite these advantages, this transition also has potential negative consequences. Included in these are: mental health complications, loneliness, lack of a bonding formed between peers and superiors, in-person worker bias, and many others (as will be described in the literature review). It is for this reason that videoconferencing should be thoroughly and exhaustively researched over the coming years so that its downfalls can be identified and its negative differences to in-person meetings can be mitigated. The abrupt and widespread implementation of virtual meetings is likely to have some issues.

1.2. Existing Problems with Videoconferencing

Naturally, due to its sudden widespread implementation, there are multiple issues regarding the use of videoconferencing. Some examples of this were listed previously, with two prime examples being mental health complications and internal in-person worker biases. This report focuses on one aspect of videoconferencing called 'self-view'. Self-view is the picture that is displayed for all meeting participants during a virtual meeting, which shows the participants own image. This is viewable to the participant themselves and, as far as this report is aware, there is little to no research on the effects of using self-view during meetings. The use of this feature thus far has been left unquestioned in literature. There is presently a feature to allow the toggling of self-view on most videoconferencing software depending on how comfortable the participant feels with viewing their own image. A further option for participants is to simply turn off their webcam. However, this raises crucial questions about what the effects of this are from a work and success point of view. Does viewing your own image impact efficiency of work through attention? The experiment places particular focus on whether viewing your own image affects attention levels during videoconferencing.

The foundation of this report takes particular inspiration from a paper written by Jeremy Bailenson. Bailenson analyses the self-view feature and describes this as an 'All-Day Mirror' [2]. He describes how unnatural this feature is in comparison to everyday life and in-person meetings. Being able to stare at an image of ourselves throughout meetings is not typically something that occurs during in-person meetings, and this also does not occur outside of videoconferencing situations. Bailenson expresses this as a design decision that "hasn't been seen before in the history of media and likely the history of people", which brings light to the fact that this component is not used in any other setting and leads us to question why this is. There are numerous issues that arise because of constantly witnessing self-view but, equally, this may have some advantages.

Viewing your own image for an extended period can require an increased number of attentional resources [3]. It is entirely natural to direct some attention towards your own image and this therefore decreases the number of attentional resources available to attend to the other parts of the meeting. Conversely, having the webcam on and seeing your own image may require the individual to be more 'switched on' as they are aware of meeting participants watching them. This diminishes the likelihood of attending to other work, such as emails, during a meeting which would imply more attention is paid. On the other hand, such multitasking may have the power to increase productivity. Though, being 'switched on' itself may require a significant portion of attentional resources, leaving little left to attend to the meeting and increasing the likelihood of experiencing 'Meeting Fatigue'. These questions and theories are further explained in the literature review based past experiments and literature. There is currently no conclusive evidence of whether self-view significantly effects participant performance during a meeting, especially in terms of attention. This gap in the literature is where this report can be of great value.

1.3. This Experiment

This report presents an experiment devised to analyse these videoconferencing-related issues using the format of a pre-constructed and pre-recorded meeting. It aims to investigate whether there is an attentional difference in a videoconferencing setting amongst groups who have their webcam on in comparison to those who have their webcam off. These differences in attention will be thoroughly analysed and any extraneous factors will be reviewed. This report will first present a literature review providing a background on the relevant literature of remote meetings, in-person meetings, meeting fatigue, telepresence, and theories that make up the foundation of these. After an understanding of videoconferencing background has been well developed, a comprehensive method is then provided, followed by a thorough data analysis. These results are discussed in terms of their descriptive statistics and their statistical testing, whilst being critically evaluated afterwards. A discussion is presented, and a conclusion is put forward for future improvements to videoconferencing.

2. LITERATURE REVIEW

2.1. Attention in Videoconferencing

Attention is a process at the heart of aspects that underpin fundamental human nature: forming memories, executing tasks, retaining knowledge, and numerous other aspects of life [26]. Attention is typically defined as the important ability to flexibly control neurological resources [23] by allocating these resources towards one of many visual stimuli or trains of thought [17]. William James, an extremely influential psychologist and philosopher, described attention as encompassing three primary factors: focalisation, concentration, and consciousness [17]. This concept underpins the nature of videoconferencing where, for meeting content to be retained and comprehended, attention must be paid to it. However, attention cannot be easily and constantly paid to all stimuli throughout a meeting. The Attention Restoration Theory, as described by Kaplan [19], describes how sustained attention to a stimulus can use up limited attentional resources which can, in turn, deplete energy. It is therefore extremely inefficient and unfeasible to pay sustained attention to all meeting stimuli and it is therefore more efficient to place focus on a few important objects amongst the rich visual stimuli [31]. It is questioned in this experiment whether the webcam of an individual being off or on can affect attention or use of attentional resources, and this is assessed using the concept of 'change blindness'.

Change blindness, coined by Ronald Rensink [28], is the perceptual phenomenon in which there is a failure to notice large changes to visual stimuli when the changes occur during a brief visual disruption. A significant example of this was displayed by Simons and Levin (1998) [31] during their experiment where an experimenter initiated a conversation with a pedestrian. During the interaction followed by a moment of disruption, the experimenter was replaced by an entirely different experimenter. Only half of the pedestrians detected this change, showing that objects attended to can remain undetected even in real-world settings, not just in experimental lab settings. Jensen et al. (2011) describe five key components of successful change detection, where the primary element is for direct attention to be targeted towards the change location [18]. Information regarding the state of the target location is to be encoded before and after the change, and a comparison is required for a conscious recognition of this difference. Encoding requires direct attention because it involves establishing a representation of the before and after state of a stimulus by using memory, and this displays the significant link between lack of attention and susceptibility to change blindness.

Change blindness is used in this experiment as a measure of attention paid throughout the meeting. For an experiment to accurately measure change blindness, there must be no indication about any changes that may occur [18]. This experiment aimed to use measures of attention to assess any attentional differences between those who had their webcam on in contrast those who had their webcam off. Results of this could amend future videoconferencing features and models, for example companies or educational institutions who require their participants to have their webcam exclusively on or off.

2.2. Meeting Science

Schwartzman (1986) [30] paved the way for a discipline named 'meeting science', where he encouraged the importance of discussing meetings and their framework very early on. He explained meetings as 'prearranged gatherings occurring between two or more individuals for the purpose of work-related interaction'. This field can be described as the systematic study of what happens prior to, during, and after meetings, as well as the components that constitute a good meeting and how these fit into the context of organisations [22]. The discipline aims to investigate aspects that make a

'good' meeting such as: the 'leader', the mode, the time, the team, and the contexts of a meeting [5]. Allen [1] takes the time to expand on the definitions and aims of meeting science by explaining that, what could be seen as merely 'workplace gatherings' as Schwartzman once described, is really a place for rich social interaction where individuals and teams can present themselves to portray particular visions. As previously described, it was only recently that the world was forced into an entire workplace in-person to virtual shift. After significant research, meeting science of virtual meetings has, naturally, not been as thoroughly investigated as in-person meetings and it is therefore vital to critically evaluate the framework behind virtual meetings to assess its benefits and shortcomings. There are significant differences in meeting science between in-person and virtual meetings due to the different components (mute button, turn off webcam options, all-day mirror, etc...) and the different role of 'presence' in virtual meetings. This experiment aims to contribute to meeting science theory in regards to virtual meetings to describe the effects of such videoconferencing specific components, such as the use of webcam.

A significant portion of meeting science involves 'teams'; how such teams are built and the role they play in meetings. For videoconferencing, *virtual* teams must be assessed. Dulebohn and Hoch (2017) analysed this, describing virtual teams as "work arrangements where team members are geographically dispersed, have limited face-to-face contact, and work interdependently through the use of electronic communication media to achieve common goals" [8]. There are some advantages to this, for example the geographical accessibility to be able to represent a particular organisation and participate in meetings from anywhere globally whilst allowing money to be saved [16]. Though, this can elicit communicational difficulties where bonds cannot be formed as easily through small talk. They also described the disadvantage of lower team engagement by team members due to difficulties creating bonds and trust among colleagues [3]. Less engagement in this form can cause less attention paid, as it may interest the individual less. In the previously mentioned change blindness study by Simons and Levin (1998) [31] regarding the changing experimenter, they found that there was a significant effect of social group. Those who felt as if they were from the same social group as the experimenters felt as if the experimenters were more meaningful to them and detected the change more successfully than those who did not. This may have a significant effect in videoconferencing situations as a result; if an individual does not adequately feel like part of the team, they may allocate less attentional resources to the meeting.

Another aspect of meeting science that is increasingly relevant in videoconferencing settings is the concept of 'multitasking'. During in-person meetings, it may be considered 'respectful' to pay undivided attention and to appear as if you are doing so. However, in virtual meetings, people are unaware of the actions of the individual behind the screen, regardless of whether they have their webcam on or off. Cao et al. (2021) [5] found that around 30% of meetings involved email-related multitasking. Executing multiple different tasks simultaneously may be commonly interpreted as paying less attention to the primary task, in this case taking part in a virtual meeting. From this, it could be suggested that turning off one's webcam would naturally lead to higher multitasking and therefore less attention paid. However, Cao et al. (2021) thoroughly analysed multitasking behaviours, finding a plethora of positive outcomes as well as negative. 15% of individuals [5] stated that multitasking helped boost their productivity, which allowed them enhanced knowledge to be formed on the most important parts of the meeting due to more attentional resources allocated to specific parts of the meeting or more time to further research relevant areas. 36% of individuals mentioned a loss of engagement and attention, by losing track of the meeting content. Though, this is typically viewed negatively as displayed in the same study, where it was reported that multitasking is also perceived as rude or disrespectful, which could have a consequential impact on communication and collaboration within teams.

2.3. Telepresence

As previously discussed, being 'present' during an in-person meeting introduces many differences to being 'present' in a virtual meeting. These components are all interlinked with theories of meeting science, virtual communication, meeting fatigue (which will be discussed). Telepresence, as described by Strengers (2014) [34] aims to replicate the way in which people communicate during in-person meetings, but virtually. Another aspect of team building which could affect attention paid is the concept of 'passive face time'. As studied by Elsbach et al. (2010) [9], passive face time is the idea that people are passively observed without direct interaction and that this influences how people are perceived at work by colleagues and managers. By being seen across the office having a conversation with someone else or walking past someone's desk, these simple interactions can affect perception of colleagues. They describe the notion that, through passive face time, people who work in the office are more likely to have the connotations of being 'committed' and 'dedicated' and a Futurestep poll [4] of 1320 global executives bolster this idea by finding that 61% of senior managers think telecommuters are not as likely as conventional office workers to be promoted. This exposes a huge flaw in the videoconferencing area and may have an impact on the level of attentional resources a worker may allocate to a meeting.

An individual turning their webcam off during a meeting may elicit changes in perception by colleagues and managers by the lack of body language being displayed. Famous psychologist Albert Mehrabian (1972) [24] found that 55% of our communicational impact comes from body language, whereas only 38% comes from the tone of voice and just 7% from the actual words used. Bolstering this, Jonathan Taylor, a senior psychologist at Pearn Kandola business psychology firm [12], stated that in a 10-minute conversation an individual can display up to 150 micro-behaviours and that these allow trust to be built with an individual as well as displaying their thoughts and intent. From these results, it could be concluded to be mandatory for a webcam to be on for the purposes of reducing bias amongst colleagues and managers. However, the results of this experiment could act as a factor in this decision and make this suggestion less feasible.

2.4. Meeting Fatigue

Since the increase of virtual meetings, a recent phenomenon has emerged called 'meeting fatigue'. This is the notion of people feeling exhausted due to engaging in lengthy bouts of videoconferencing, in comparison to the less fatiguing in-person meetings, for numerous different reasons [3]. Wright and Cropanzano (1998) [36] described that lower employee energy, the primary effect of meeting fatigue, is directly related to lower job performance. This simple finding indicates a significant flaw in the current state of videoconferencing and the need for future adaption.

There are various moments where meeting fatigue is most likely to occur and the majority of these are due to increased or intense visual stimuli that requires more attentional resources. Spataro (2020) [32] attributed evidence of meeting fatigue to the fact that videoconferences require increased sustained attention in comparison to in-person meetings. In videoconferencing settings, the individual is required to sustain prolonged direct eye gaze with the primary speaker for longer periods of time, but this same act could be perceived as intense and inappropriate during in-person meetings [2]. Furthermore, the images of others on screen are large in size and close to the individual and this may therefore require even more attentional resources as well as eliciting some biochemical changes [25]. It is also natural for individuals to look at various different people during a virtual meeting, even those who are not speaking. It is not always the case that the primary speaker is being solely looked at, though in-person meetings would not find people staring at non-speaking individuals. This means there are more faces to attend to [25], as well as the attentional resources required to assess each person's actions and mood. Since in-person meetings allow everyone to be in the same context and environment, many more attentional resources are directed to each person's background during virtual meetings, especially since many people are working in their own home [11]. Another more relevant factor to this experiment is the own image of an individual, which could lead the individual to continually consider their own image and appearance [11].

Since its manifestation as part of meeting science, it has been intensely investigated and some factors that can diminish meeting fatigue have been identified. The result of this investigation links tightly with the previous theories of virtual communication and telepresence, where group belongingness was one of the most significant factors affecting meeting science [3]. Individuals in an experiment by Bennett and Campion (2021) [3] were split based on their levels of group belongingness. Those who felt high group belonginess displayed less meeting fatigue overall. Those with low group belongingness experienced higher meeting fatigue levels, but these were lowered if they used their microphone more and the mute function less, further bolstering the importance of proper virtual team communication and group belongingness. They also cited a finding that described higher task disengagement leading to higher meeting fatigue, supporting the idea that being more active in a meeting replenishes mental resources [15].

The Attention Restoration Theory (ART) heavily contradicts this theory by proposing that meeting fatigue can be reduced through the act of 'being away' [19]. It suggests that this act of detachment by the individual can be done by muting oneself, turning off one's webcam or not looking at their own image on the screen [3]. The notion states that, by not doing these things, less resources are required and therefore meeting fatigue is reduced which implies that more attention is paid when the webcam is off. This requires further investigation but, nevertheless, this theory can have great implications on the results of this experiment.

2.5. Media Naturalness Theory (MNT)

The Media Naturalness Theory (MNT) is based on Darwinian evolutionary principles to suggest that the human brain has evolved to favour face-to-face communication over virtual communication. It further states that the closer an encounter is to face-to-face communication, the lower the cognitive effort required [21]. For communication to be as natural as possible in fitting with MNT: participants should be in a common location, participants must be in synchronicity allowing for immediate communicate exchanges, they must have the ability to observe and convey facial expressions, body language and listen to speech [20]. Videoconferencing does not always allow for these components to be natural or present at all, and this underpins some issues of meeting fatigue.

Karl and Peluchette (2021) [20] gathered data from various LinkedIn posts discussing videoconferencing etiquette and analysed these by extracting their primary topics. Over 60% of these comments focused on webcam and microphone issues, which displays the imperfections of such components in videoconferencing settings. MNT also suggests that any communication that does not closely align with the conventions of face-to-face communication causes an information overload, using more attentional resources and therefore allowing less productivity and more fatigue [14]. This theory has significant links to the experiment at hand, where webcam use can be significantly adapted to make communication across this mode as natural and as effective as possible.

3. EMPIRICAL STUDY

- The two experiment conditions can be found at: https://kiran-nicole-rai.github.io/.
- The source code for this experiment can be found at: https://github.com/kiran-nicole-rai/kiran-nicole-rai.github.io (available under an MIT licence).

3.1. Method

3.1.1. Participants

This experiment was conducted on 58 volunteer participants aged 18 or over and all were recruited via an opportunistic sample. The participants were recruited by means of WhatsApp, LinkedIn, Facebook, and Instagram. Upon the recruitment of each participant, they were asked whether they had access to a webcam and to a laptop or PC. Some were therefore unable to complete the experiment due to lack of a computer, and the remaining participants were manually sorted between two conditions depending on whether they had access to a webcam. After sorting the participants in this manner, if the conditions were unbalanced, participants were assigned to conditions based on the current participant count of each condition.

3.1.2. Design

This experiment was carried out as statistical independent groups, between-subjects design. There was one independent variable present in this study, named 'webcam'. This variable was determined by whether the participants had their webcam 'ON' (the name of condition one) or 'OFF' (the name of condition two). There were 29 participants in each of these conditions. The dependent variable was number of changed visual stimuli that was successfully noticed and recalled by the participant. This was measured using change blindness theory through the means of participating in a pre-recorded meeting and subsequently answering some questions.

3.1.3. Materials

The only materials the participant required was access to a laptop or PC, internet access with sufficient bandwidth and, for some, a webcam. If the participant was recruited via LinkedIn, they were directed to a general link (at: kiran-nicole-rai.github.io) which had links to either experiment one (with the participant's webcam on), or experiment two (with the participant's webcam off). If the participant was in possession of a webcam and was willing to partake in the experiment, they were directed to a different link (kiran-nicole-rai.github.io/experiment1) than those without a webcam (kiran-nicole-rai.github.io/experiment2). When clicking on either of the two experimental links the participant was shown a webpage that, in summary, played an MP4 file of a pre-recorded meeting. The end of this meeting automatically redirected the participant to a Google Forms page, where the individual was required to answer 17 short questions.

3.1.3.1. Meeting and FFMPEG

The creation of the meeting was the primary and most central component to the development of this experiment. It was first deliberated whether it was more appropriate to conduct this experiment via inviting the participant to a real meeting held on the popular videoconferencing platform Zoom, or to pre-record the meeting and play this for the participants. What was planned to be a 10-minute video when edited would likely have taken at least 20 minutes including mistakes

made, introductions, goodbyes, any technical difficulties and waiting for the participant to join the meeting. The target was to receive at least 50 participants, and therefore this would have taken 16 to 17 hours overall, not including any rescheduling needed. A further issue was presented by having to arrange a time by comparing the schedule of the experimenter with the schedules of the participant and the actors, something that would have proven extremely difficult due to busy schedules. Therefore, it was deemed more appropriate to pre-record this meeting due to the limited time available to host each of these meetings directly and individually.

Four coursemates on the University of Birmingham MSc Human-Computer Interaction course were chosen to act in this meeting. Four were chosen for multiple reasons, just one of these being difficulty to arrange a mutual free time with more people since all four individuals were amidst completing their own dissertation. Less than four individuals were not thought to be appropriate since there are rarely meetings with this little people, but four was enough for a conversation to be held as a group. It was concluded that, if needed, a 'guest' could be added into the 'meeting' for the appearance of more participants. When deciding a topic for the meeting, a medium ground between current events and the topic of this final project was chosen. Therefore, the meeting was about the future of work and education after the COVID-19 pandemic is over. The aim was for this meeting to not be a presentation, but more of a conversation and general discussion of the topic. As a result, a 42-line script was written on this topic and each line was designated to one of the actors. One individual was appointed as the unspoken meeting head, who introduced the meeting and concluded it.

Once a mutual free hour was found between the actors and the experimenter, the script was performed over Zoom. It was recorded both on the laptop of the experimenter and on Zoom itself, for safety. Each actor was provided with a large JPG or PNG background image to equip during the meeting. Two of the actors were provided with two different backgrounds, and they would change their background at separate intervals when requested to by the experimenter. They did this by turning their webcam off whilst they changed the background, then turning it back on. Similarly, one actor was asked to change their outfit during this experiment. This actor also had two backgrounds, and therefore turned off their webcam to change both their background and outfit. These components of background, outfit and name were chosen to be altered because these are the three primary visual aspects of a meeting and therefore these were believed to be representative of attention to visual stimuli. The placement of individual videos is also a visual stimulus that can be changed, but this change is already something that naturally occurs in virtual meetings. This took around one hour to record in total including: the script itself, the introduction to the experiment by the experimenter, and general conversation in-between. The final input video was 21 minutes and 44 seconds long, with no pauses in-between (the original input video is displayed in figure 1). The recording was not paused during the Zoom meeting because it was thought to be more appropriate to do all editing afterwards. The recording was saved and the actors were informed of the possibility of re-recording certain parts or lines, if necessary.

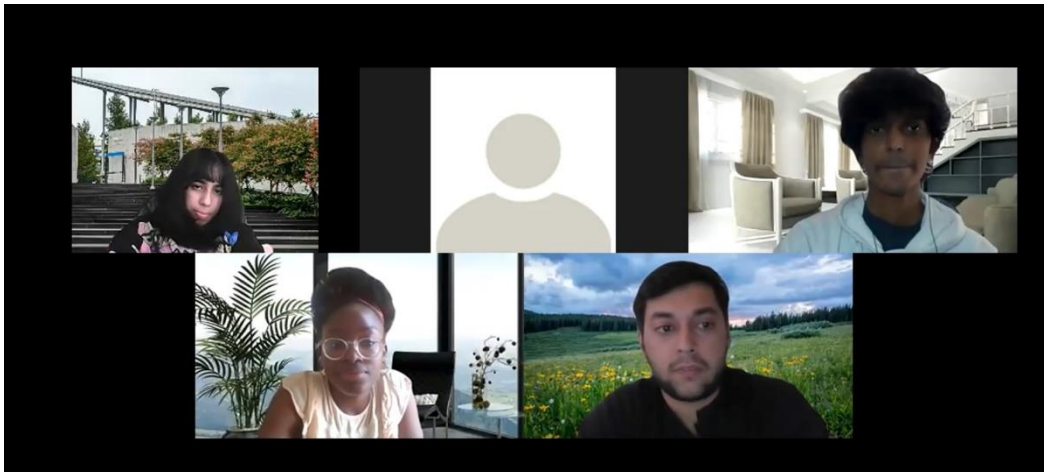

Figure 1: The original input video before editing.

Several video editing software were considered for this task, one of these being 'Blender'. However, the nature of this video required cropping each actor's video separately due to a different actor potentially laughing during another actor's lines. Therefore, the target was to crop each actor's video as an individual MP4 and then composite the required clips together. It proved very difficult to achieve this in Blender and therefore research was conducted into the most appropriate alternative editing tool for the aims of this experiment. FFMPEG was a very popularly used tool due to its power and detail in handling video and audio files. Because the tool is for use exclusively in the command line, FFMPEG had to be learnt before beginning to use it on the meeting input file.

Once a basic knowledge of FFMPEG had been grasped, the input file for the recorded meeting began undergoing editing. Using a Windows scripting file (batch file), all of which can be viewed in the GitHub repository, the first step of the editing process was to crop each actor's individual video. This was done by providing the specific pixels for each of the four corners to be cut out. Once each actor had their own output video in their name, the beginning and end times for each of the script lines were determined. One 'cut' ran through the script lines until there was an error made, an instruction provided by the experimenter, or if someone was laughing. As a result, 13 separate MP4 clips were made for each actor, which encompassed all 42 lines without any errors. An example of one clip for one individual is shown in figure 2. These had to be scaled to the appropriate size to fit fullscreen on the browser of the participant. These individual actor clips were 374 by 232 pixels each. The size for the final output was aimed to be 1920 by 1080 pixels, a size that was appropriate for fullscreen after some research. This final output would encompass the 13 script line videos, with each made up of four actors, one participant, and one 'guest'. Therefore, it was decided to split these videos up into a 3 by 2 grid, meaning that the scale for each actor clip would have to be scaled to 640 by 540 pixels. This was also done using a batch file as each of the 52 clips (13 clips each for four actors) were scaled to size.

Figure 2: Example of one cut out clip for one actor.

After this, three JPG files were gathered. Respectively, these were a: plain black image, a plain grey image with the phrase "Emerson (Guest)" written in white, and a plain grey image with the phrase "You (Guest)" written in white. The black image was the space designated for the participant's webcam to be placed in the 'webcam ON' condition. The grey image stating "You (Guest)" was where the participant would believe their video would be in the 'webcam OFF' condition. The grey image stating "Emerson (Guest)" was the space where the participant would believe a guest is listening to the meeting. Using three separate batch files, each of these images were transformed into 13 respective MP4 videos with a length to fit each of the clips, and all with the appropriate 640 by

540 pixel scaling. A 'composite' batch file was created to composite this altogether. One line in this batch file combined a single clip of each of the four actors, the participants video, and the guest's video into one video and outputting the final clip with all these relevant videos. Clips where an actor turned their webcam off were replaced by a grey image with their name on it. An example of this is shown in figures 3 and 4, where the former is a screenshot from the original input video where an actor's webcam was turned off, and the latter shows the output video's replacement for this. There were therefore 13 lines in this batch file, one for each clip. Each clip was arranged so that the top three videos were actors, the bottom left video was the remaining actor, the bottom middle video was the participant, and the bottom right video was for the guest. This file was run twice; once for the 'webcam ON' condition and once for the 'webcam OFF' condition, each with the appropriate participant video.

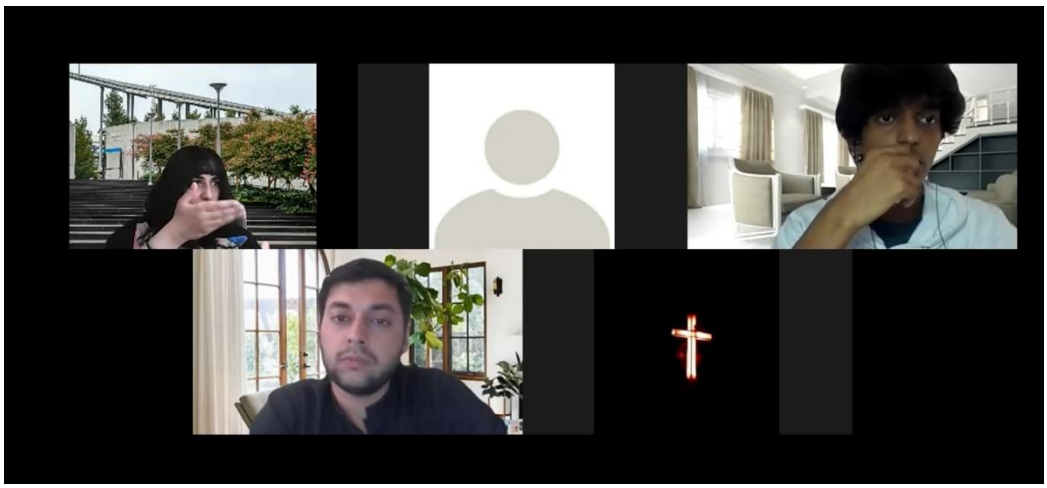

Figure 3: A screenshot from the original input video where one actor's video was turned off.

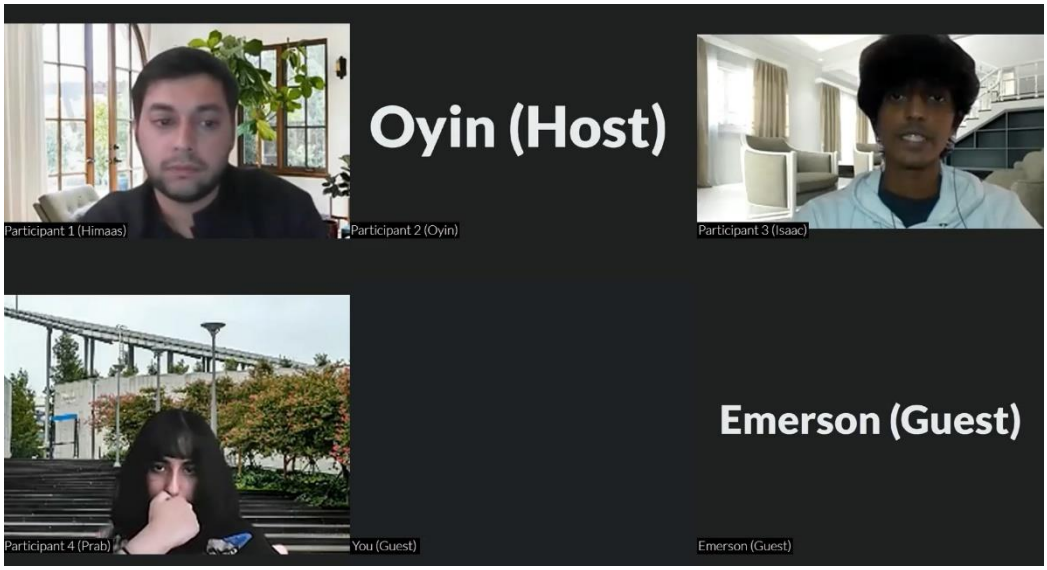

Figure 4: The MP4 replacement created for the actor's video being turned off.

The next stage of this process was to add banners onto each video. Using the application 'Paint', six banners in JPG form were created for the six people believed to be partaking in this meeting, and they included the name of the individual as well as their role in the meeting. In order, these banners read: 'Participant 1 (Himaas)', 'Participant 2 (Oyin)', 'Participant 3 (Isaac)',

'Participant 4 (Prab)', 'You (Guest)', and 'Emerson (Guest)'. This experiment also aimed to change the name of an individual to see if the participants noticed this, so the name of 'Participant 3 (Isaac)' changed to 'Participant 3 (Toby)' at one point in the video. These banners were added to each clip at the relevant positioning in pixels to the corresponding video. An issue presented itself of transitioning these clips together, as they appeared 'jumpy' and 'fake' when placed together. To combat this, the video appeared as if it had frozen for a few seconds at the end of each clip, which is a natural part of people's experience of videoconferencing, so the transition between clips appeared smooth and natural. To do this, the last frame was taken from each clip using a batch file, and then turned into a 3 second video. The final stage of the editing process was to concatenate all these 13 clips together with the 'frozen' transitioning clips in between. This was done by listing all the file names in a TXT file and concatenating them using FFMPEG. This provided two output videos, one for each of the conditions. The final outputs for the 'webcam ON' condition and the 'webcam OFF' condition are shown below in figures 5 and 6, respectively.

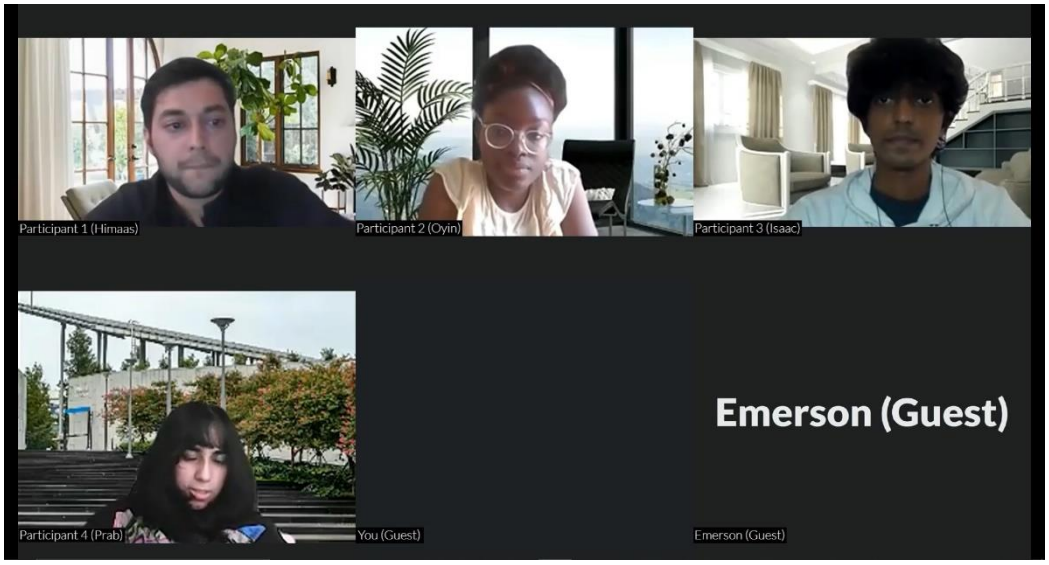

Figure 5: The final output video for the 'webcam ON' condition.

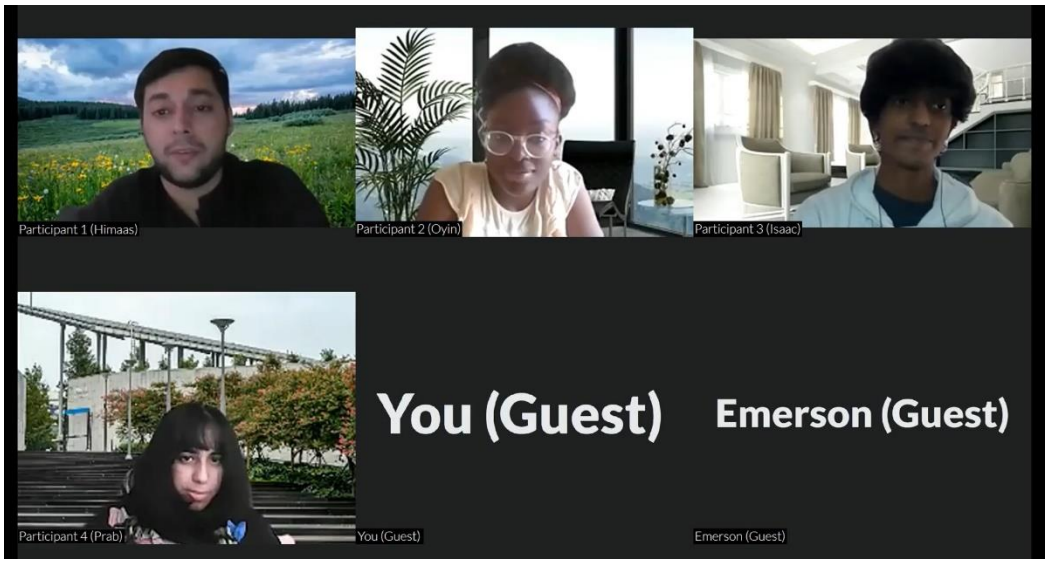

Figure 6: The final output video for the 'webcam OFF' condition.

3.1.3.2. Google Forms

To assess the attention and retention of the participant during this meeting, a questionnaire was created to answer after participating in the meeting. Google Forms was considered an accessible and familiar choice as a method of asking questions, especially since it summarised the results in a desirable way. This form encompassed 17 questions in four respective sections.

The first section was merely an introduction to the form and explained what was required of the participant, which was to complete the form based on the meeting they just participated in. It asked the participant to answer all questions honestly without referring to the meeting, as this would invalidate the results because it would alter their recall of the meeting. Participants were also informed that all responses were confidential and directed to an email if they needed to ask any questions. This section is shown in figure 7. This followed on to the second section, composed of four questions. It began by asking the age of the participant assessed by age bands, which was asked for the purpose of evaluating whether this had a correlation to the results at a later juncture. Participants were asked whether they were able to work or study from home during the height of COVID-19, which was asked to assess whether there was more attention paid to changing details when the individual had more familiarity with the 'virtual meeting' mode of working. The third question asked whether the participant knew the actors in real life, as the individuals who answered 'Yes' to this would have to be excluded from questions regarding name recall otherwise the results would be invalidated. The final question asked whether the participants webcam was on or off, to assess which condition they would be placed in.

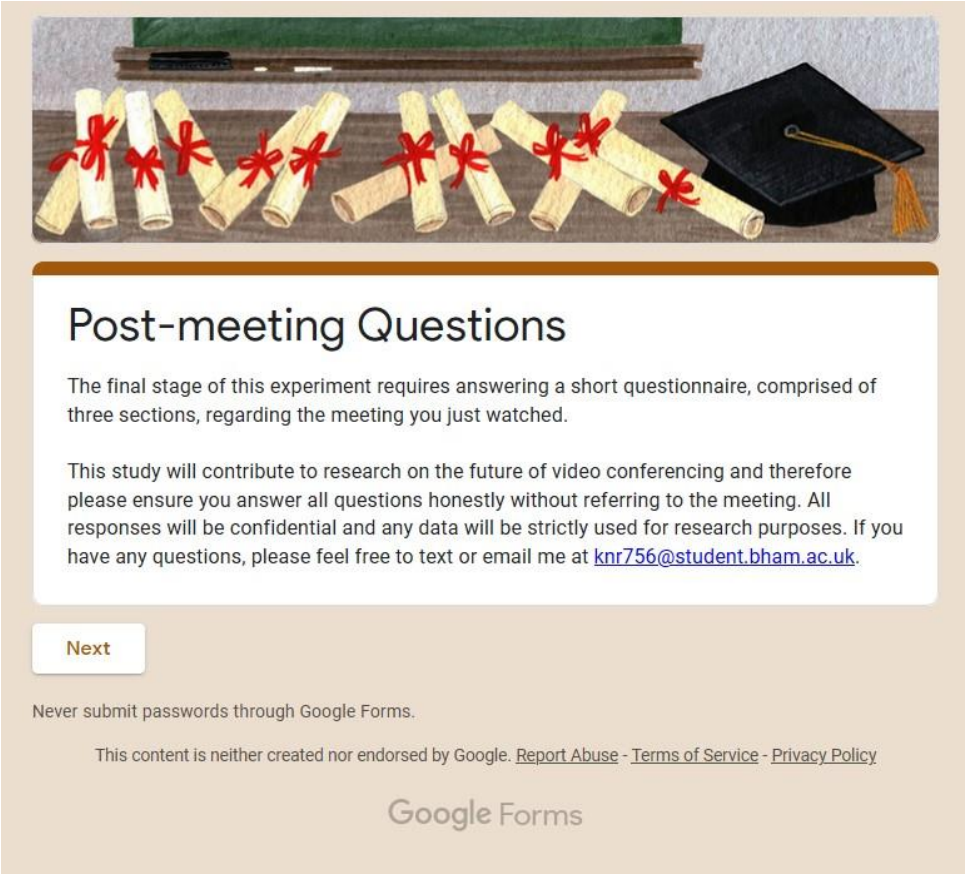

Figure 7: The introductory section to the questionnaire.

The third section of the questionnaire surrounded the participant's opinions on the meeting and was also composed of four questions. This section was not as relevant to the study as the participant may believe, as the focus of this study was not about their opinions on the topics mentioned. Regardless, as a means of briefly ensuring the participant was listening to the meeting at any point, the participant was asked to provide a short summary of the meeting as well as their brief opinions. They were then asked, using likert scales, how interesting they found the meeting and how difficult they found it to concentrate. It would be later assessed for any correlation in the results.

The fourth and final section of this questionnaire was the most crucial to the aims of this experiment. This questioned what was noticed and recalled about the meeting and included the remaining nine questions. It began by asking the participant to recall the names of the four actors (called the 'meeting participants') and the 'guest' with their webcam off. It then followed by asking if they recalled any actor changing their name throughout the meeting, and then asking what they believed this name was. Participants were then presented with six images of the actor who changed their clothes in six different outfits and asked which of these they recalled seeing. Finally, participants were presented with 12 different potential background images (see appendix) and asked which of these they recalled seeing, where six of these were correct and used during the meeting video.

Google Forms provides the creator with a link to share with participants and this was considered, but it was thought to be easier for the participant to be automatically redirected there after finishing the video. This meant that participants would answer the questionnaire immediately after the meeting with no time in-between for the participant's recall to be overwritten or decayed. This platform counts all responses and compiles these all into a compiled summary form, which assisted immensely in balancing the participants between the two conditions. All questionnaire questions will be inserted into the appendix of this report.

3.1.3.3. Experimental HTML Files

A HTML file was created in the developer application 'Atom'. This file began by inserting a video element onto the page, which was connected to the source of the video on the laptop of the experimenter. Below this, another video element was inserted where the webcam of the participant would be placed. An introduction is then provided to the participant where they are welcomed to the experiment and informed of some details. The contents of this introduction (for the 'webcam ON' condition) was as follows:

> " Hello! My name is Kiran Nicole Rai and I am currently working on my final project as part of the Human-Computer Interaction MSc program at the University of Birmingham. This experiment is under the supervision of Russell Beale, a professor of Human-Computer Interaction at the university. This experiment is a component of my dissertation. Your data and responses will be recorded anonymously and used for research purposes only.
>
> For this experiment, you must use a laptop or PC. You MUST have your webcam on. Your video will not be recorded. You will be a guest in a meeting of four university students and you must pay attention throughout this experiment as you will be asked some questions at the end. The meeting will last for just under 10 minutes and, when the meeting has finished, you will be automatically redirected to a Google Forms page where you will be asked the questions. Once you begin the meeting, you will not be able to fast forward nor rewind it, but you may pause. Upon pausing the meeting, you will not be able to see anything until you press play again. You must NOT refresh the page at any time or you will have to restart the experiment. Do not worry if the meeting sometimes freezes for a few seconds - this is normal.
>
> If you have any questions, please feel free to text or email me at knr756@student.bham.ac.uk. Please

press 'Begin Meeting' whenever you are ready to start the experiment. If you have paused, press 'Play' whenever you are ready to resume the experiment.</p> ”

Participants were warned to the fact that it may appear as if the meeting is freezing momentarily so that they do not refresh the page because of it. The popular JavaScript library jQuery was imported into this script for the ease of writing it. A button was placed at the bottom of the HTML page and, in the script, this button began by displaying ‘Begin Meeting’. An example of this playing in the browser is shown in figure 8. Once the participant had pressed this button, the introduction text disappeared and the video began playing, with an example of this displayed in figure 9. If the participant wished to press this button, which now displays ‘Pause’, the video is paused and disappears from the page and the introduction text is brought back up, shown in figure 10. This is brought back up in case the participant needs reminding of the instructions, and the video disappears so the participant does not receive extra time to encode information in this meeting. They then had the option to press the button again, which now displays ‘Resume’, and made the information text re-disappear, and plays the video from where it left off. These actions were all placed into one ‘startMeeting()’ function which was called upon pressing the button.

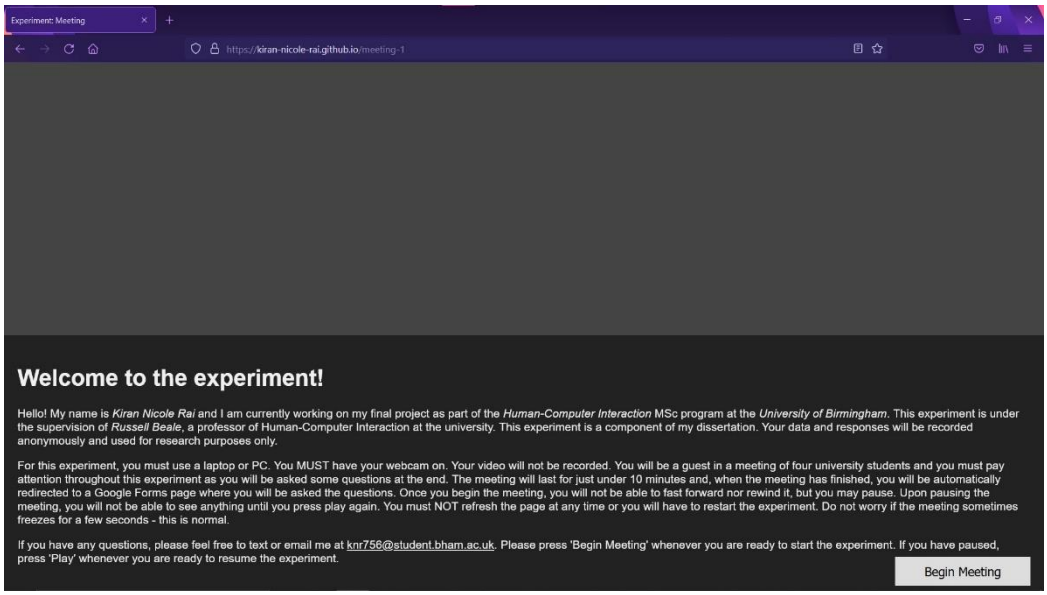

Figure 8: The screen for meeting one (webcam ON) before the meeting has started, showing instructions and a 'begin meeting' button.

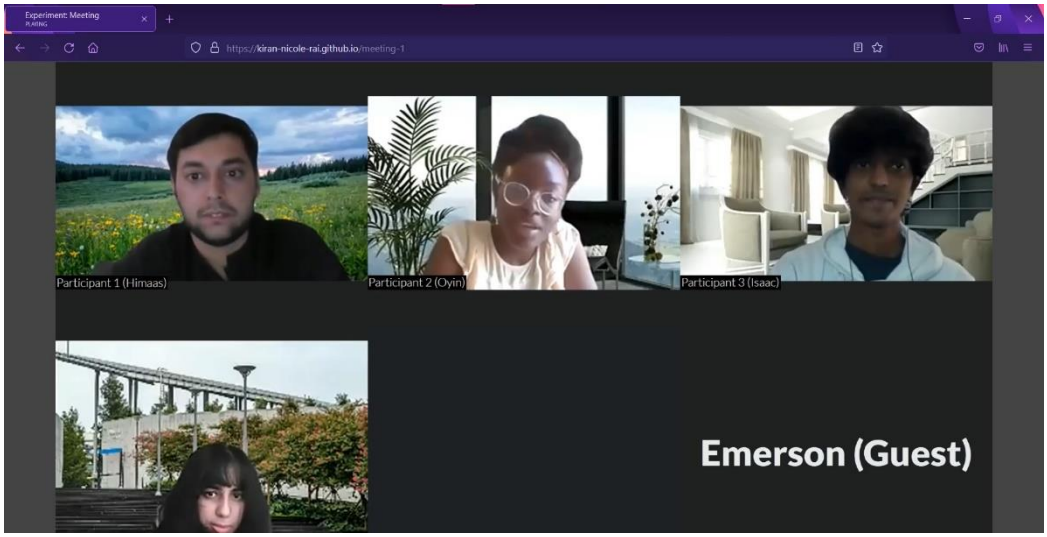

Figure 9: The meeting playing in the browser, with a button to 'Pause' the meeting.

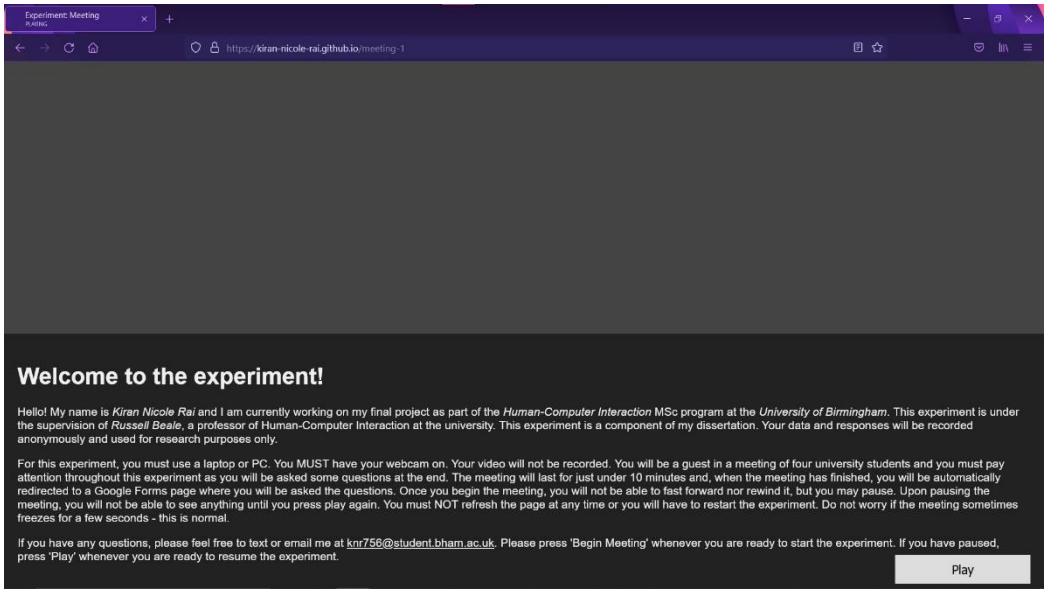

Figure 8: Whilst the meeting has been paused and the instructions brought back up, with a button to resume the meeting by pressing 'Play'.

Part of the JavaScript in this file utilises an open source code block from David Walsh [35] to access and use the webcam of the participant. Therefore, the webcam was able to be used by other methods in this script by accessing the tag from its video element. Using this, a placeCamera() function was created which placed the webcam on the appropriate part of the video. Using CSS, the meeting video was made fullscreen and placed centrally in the browser, but if the participant resized their browser, the webcam would be placed incorrectly. Therefore, the aim of this method was to place the webcam video in the designated space of the meeting video, no matter if the window was resized vertically or horizontally. This method calculated the size of the window every time the participant resized their browser. It firstly calculated this using the aspect ratio to identify whether the offset black bars were horizontally above and below the video, or vertically either side of the video. Using this information, the size of the bars were measured in comparison to the size of the original video, and the webcam was placed accordingly.

At the end of this meeting, an EventListener was put in place which called the 'endMeeting()' function. This function provides an alert to the participant, stating "The meeting has ended and you will now be redirected to Google Forms to answer some post-meeting questions.", shown in figure 11. The participant is then automatically redirected to the Google Forms link where they complete the questionnaire. This HTML file was duplicated for the second 'webcam OFF' condition, where the lines accessing the participant's webcam were removed, and the parts of the introduction regarding the webcam were also removed. The 'webcam OFF' video is displayed in figure 12, where some changes are made to the instructions.

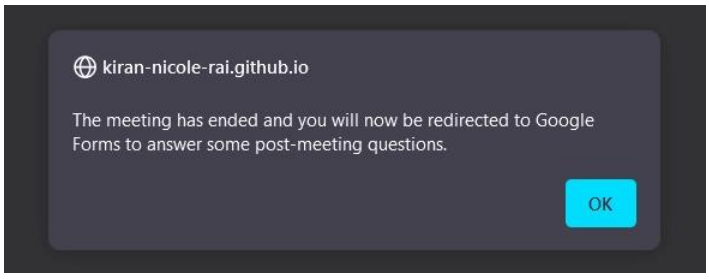

Figure 9: Automatic redirection to the questionnaire after the meeting has ended.

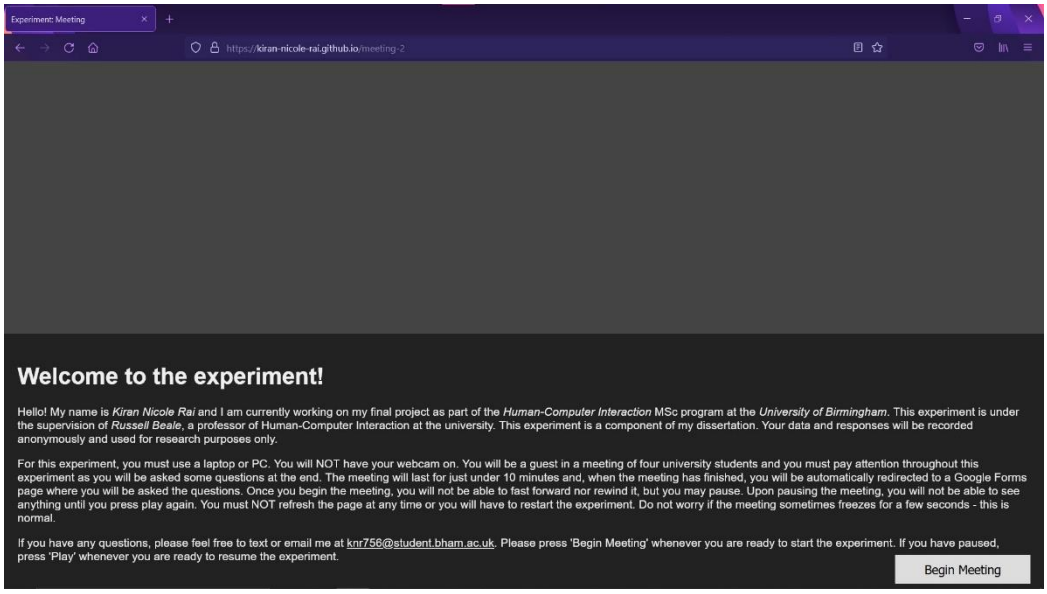

Figure 10: Meeting two (webcam OFF) experiment in the browser.

3.1.3.4. Hosting the Experiment

Before planning on hosting the experiment, the final experiment was tested by the experimenter as well as some family and friends. This was done to ensure no mistakes were made and to guarantee that it functioned adequately for the participants completing the experiment. These final iterations made were noted down during the process and can be seen in figure 13. Originally, the plan was to host these experiments from the personal website of the experimenter. However, it was discovered that, due to browser security updates, using the webcam of the participant requires a HTTPS certificate; the website this was planned to host on only used HTTP. Therefore, an alternative idea was tested where the experiment would be hosted on the localhost of the experimenter's laptop using 'ngrok' to create a secure tunnel to the participants laptop. However, this posed the same issue as the previous one as this did not use a secure HTTPS connection.

Name	Changes
Proof of Concept	Tested the final experiment myself. The cuts were too jumpy so going to extend the 'freezing' transition clip by an extra 2 seconds to 3 seconds.
Iteration #1	Tested the experiment myself. The cuts are sufficient and look more natural. Added the 'N/A' answer to the 'Were you able to work or study during the height of COVID-19?' question.
Iteration #2	Tested on a family member. Feedback - would rather the ability to pause because of interruptions from being at home and missing parts. One consistency error in the questionnaire, changed default "Option 1" to "Outfit 1".
Iteration #3	Tested on the same family member. Feedback - Resized the window vertically and the webcam became misplaced. This error was fixed.
Release Candidate #1	Tested on the same family member, no negative feedback. Tested on a friend. Feedback - would benefit from the instructions reappearing when pausing.
Release Candidate #2	Tested the final version myself. All functional. Made one sentence in the initial instructions clearer. Informed the 'Camera OFF' participants that they would NOT be recorded.

Figure 11: Final iterations and the process of finalising the experiment from the point of finishing its creation to handing it out.

After some research into solutions, it was suggested to make a GitHub repository and utilise GitHub's automatic deployment to a GitHub pages site. To do this, a GitHub account was made and a new repository, named https://kiran-nicole-rai.github.io/, was created. After the published HTTPS site was created from here, two new files were created in this directory. The 'webcam ON' condition was named' 'meeting-1', and the 'webcam OFF' condition was named 'meeting-2'. Therefore, participants were either provided the link 'https://kiran-nicole-rai.github.io/meeting-1' or 'https://kiran-nicole-rai.github.io/meeting-2' depending on the condition they were placed in.

3.1.4. Procedure

After the materials had been finalised and the links to the experiments had been successfully created, a range of participants were asked if they were able to participate in this experiment. Upon agreeing, participants were asked a follow up question about whether they had access to a webcam. Depending on whether they had a webcam or not, and also depending on how balanced the two conditions currently were, participants were provided with the corresponding experiment link.

The role of the participant was simply to participate in the 10-minute video through to the end, paying as much attention as possible and acting as they would during a typical meeting. They then had to answer the questions as honestly as possible and to the best of their ability. The participant target for this experiment was at least 50, but some further participants agreed to complete this experiment after reaching the target. Once everyone who had agreed had completed the experiment and the conditions had been balanced, the results were exported to a CSV file from Google Forms.

3.1.4.1. Data Preparation

The CSV file of the compiled results was opened in an Excel spreadsheet. When asked if the participants were able to work or study throughout the height of COVID-19, two participants answered 'Other'. Based on the content of their answers, these two responses were sorted into either 'Yes', 'No', or 'N/A' categories.

The five questions asking individuals if they recalled the names of the actors and the guest yielded many different responses, and therefore the results had to be standardised before they were to be analysed. First, each of these responses were sorted into six different categories. These categories were: completely correct, correct but wrong spelling, similar sounding, wrong person, completely incorrect, and don't know. However, after all the responses had been sorted into these categories, it was apparent that the 'similar sounding' category was too subjective to use if this experiment were to remain valid and objective. It was clear that many names were ambiguous as to whether they should be sorted into the 'similar sounding' or 'completely incorrect' categories, and because there was only one experimenter sorting these, there was no mutual agreement and therefore both of these categories were combined into one 'incorrect' category.

Columns were also created for whether the participant successfully noticed the name change, and whether they successfully noticed and recalled the name change, where the box either contained 'Yes' or 'No'. Similar columns were created for whether the participant noticed the six backgrounds used and whether they noticed the first and / or the second outfit of the actor who changed. Two further columns were created that listed a numerical value, where one counted the number of correct actor names for each participant, and one counted the number of correct backgrounds noticed. The identified actor names were interpreted as correct if they were sorted into the 'completely correct' or the 'correct but wrong spelling' category.

The data was analysed using the statistical analysis software SPSS Statistics. For the process of statistical testing, some of the nominal variables such as the webcam being 'on' or 'off' were coded as numerical values '0' and '1'. The data was first processed for frequency and descriptive statistics

data, including some explorations and crosstabulations. Three respective non-parametric statistical tests were used to analyse the results, where two tested significant differences and one tested significant correlation. These three statistical tests were: Mann-Whitney U test, Spearman's rank correlation coefficient, and the chi-squared test. The appropriate statistical test was done based on whether the relevant dependent variable was of scale (interval or ratio), ordinal, or nominal data types.

3.2. Results

3.2.1. Descriptive Statistics

The results of this experiment were sourced from 58 participants of this experiment. Of these participants, 89.7% of them were aged between 18 and 34, as can be seen in figure 14. The participants were equally split between the two conditions, 'webcam OFF and 'webcam ON, and there were therefore 29 participants in each. 82.8% of participants stated that they were able to work or study from home during the height of COVID-19.

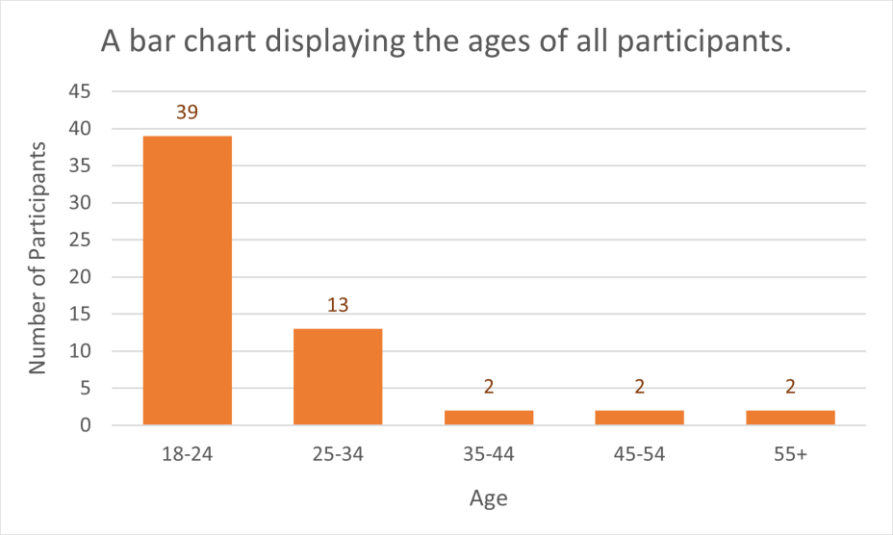

Figure 12: Ages of all participants.

On a scale of one to five where one was 'extremely uninteresting' and five was 'extremely interesting', participants rated their interest at 3.09 on average overall. This showed be a very average result but leaning slightly more towards the 'interesting' side. The overall count of these ratings can be found in figure 15. Similarly, on a scale of one to five where one was 'very easy to concentrate' and five was 'very difficult to concentrate', participants rated their average difficulty concentrating at 3.29 overall. This figure was also very average and leaned slightly further towards the 'difficult to concentrate' side. The overall count of these numbers can be found in figure 16. When split based on 'webcam' conditions, means and standard deviations for these were calculated. As seen in table 1 where participants rated their interest, the mean for the 'off' condition was 3.07, which was only slightly lower than the overall mean. For the 'on' condition, this mean was slightly higher at 3.10. Though, this condition also had a higher standard deviation (1.012) compared to the 'off' condition (0.753). The descriptive statistics for participants rating their difficulty concentrating is displayed in table 2. For the 'off' condition in this question, the mean was slightly lower than the average at 3.21. Like in table 2, the 'on' condition displayed a slightly higher mean than the average, at 3.38. Similarly, the standard deviation for the 'on' condition (1.115) was higher than in the 'off' condition (0.978).

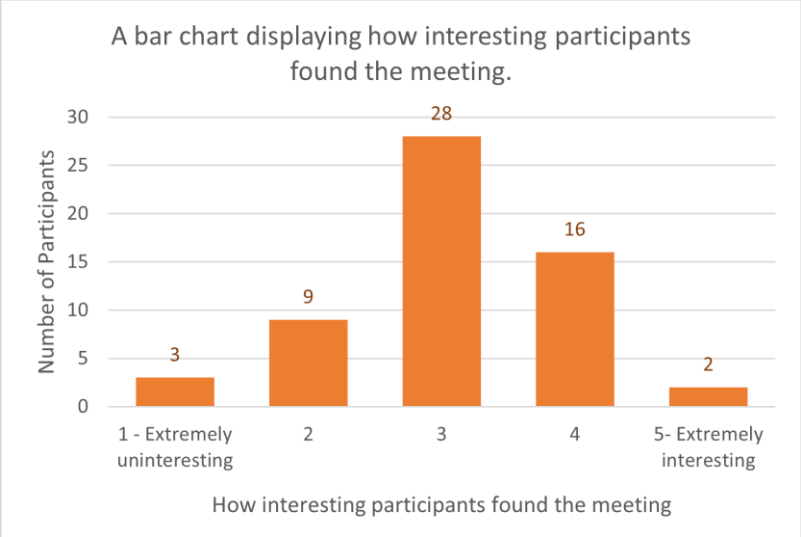

Figure 15: The frequency of how interesting participants found the meeting.

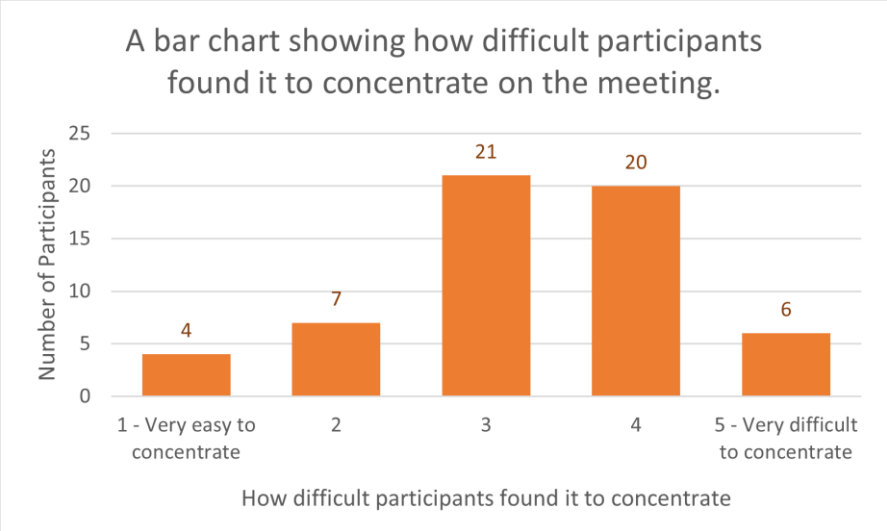

Figure 16: The frequency of how difficult participants found it to concentrate on the meeting.

Table 1: The means and standard deviations for how interesting participants found the meeting.

Condition	Mean	Standard Deviation
Webcam OFF	3.07	0.753
Webcam ON	3.10	1.012

Table 2: The means and standard deviations for how difficult participants found it to concentrate during the meeting.

Condition	Mean	Standard Deviation
Webcam OFF	3.21	0.978
Webcam ON	3.38	1.115

Table 3 displays the number of correct names for each actor in the meeting, the number of correct names identified overall, and the number of correct names for the guest in the meeting. Overall, the average number of correct names identified was 2.71 and the standard deviation for this was 1.377. 43.1% of participants correctly identified all four of the actor's names, as shown in figure 17. When split by webcam condition as seen in table 4, the descriptive statistics displayed that the 'on' condition had a slightly higher mean of correct names (2.76) than the 'off' condition (2.66). Like much of the other measures, the 'on' condition had a higher standard deviation (1.431) than the 'off' condition (1.344). Actor three, named 'Isaac' had the highest correct name identification rate at 77.6%, and the lowest incorrect identification rate at 1.7%. Actor two, named 'Oyin', had the lowest correct name identification rate at 60.3%, whereas actor one, named 'Himaas', had the highest incorrect identification rate at 20.7%. Actor two also had the highest 'unknown' identification rate at 25.9%. 60.3% of participants correctly identified the name of the guest, called 'Emerson', and 32.8% did not know the name of the guest. Furthermore, as shown in table 5, 39.7% of participants noticed that an actor's name had changed, and a lower figure of 32.8% of participants could accurately recall what this name was changed to.

Table 3: The frequency and percentage of individual correct actor names identified, overall correct actor names, and correctly identified guest names.

		Frequency	Percentage
Actor 1 (Himaas)	Correct	37	63.8
	Incorrect	12	20.7
	Unknown	9	15.5
Actor 2 (Oyin)	Correct	35	60.3
	Incorrect	8	13.8
	Unknown	15	25.9
Actor 3 (Isaac)	Correct	45	77.6
	Incorrect	1	1.7
	Unknown	12	20.7
Actor 4 (Prab)	Correct	40	69.0
	Incorrect	5	8.6
	Unknown	13	22.4
Overall Correct Actor Names	0 Correct	4	6.9
	1 Correct	11	19.0
	2 Correct	8	13.8
	3 Correct	10	17.2
	4 Correct	25	43.1
Guest (Emerson)	Correct	35	60.3
	Incorrect	4	6.9
	Unknown	19	32.8

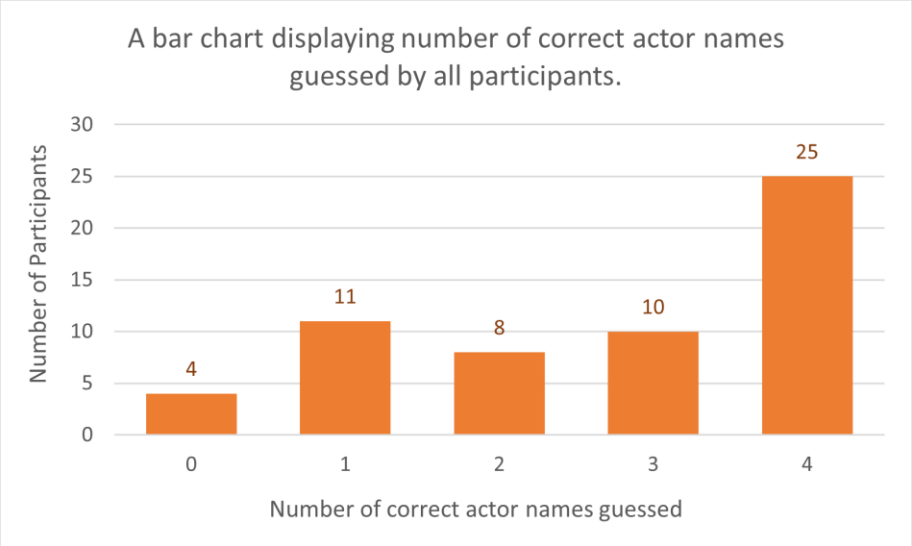

Figure 13: The number of correct actor names identified.

Table 4: The means and standard deviations for the correctly identified actor names, based on condition.

Condition	Mean	Standard Deviation
Webcam OFF	2.66	1.344
Webcam ON	2.76	1.431

Table 5: The frequency and percentage of participants who successfully noticed and recalled the name change.

		Frequency	Percentage
Successfully Noticed Name Change	Yes	23	39.7
	No	35	60.3
Successfully Recalled Name Change	Yes	19	32.8
	No	39	67.2

During the experiment, actor two changed their outfit. Displayed in table 6, 27.6% of participants correctly identified the first outfit, whereas a slightly lower figure of 25.9% of people correctly identified the second outfit. The majority of participants, 53.4%, did not correctly identify any outfits correctly. 39.7% of participants correctly identified only one outfit correctly, and the remaining figure of only 6.9% of participants identified both outfits correctly. On average, the number of overall correct outfits identified was 0.53 and the standard deviation for this figure was lower than the correct names measure, at 0.627. When split on webcam conditions shown in table 7, the 'off' condition displayed a mean of 0.55 correct outfits identified and the 'on' condition displayed a slightly lower mean figure of 0.52. The standard deviations for these two conditions were very similar, where it was 0.632 for the 'off' condition and 0.634 for the 'on' condition, showing similar amounts of variance within the two conditions.

Table 6: Frequency and percentages of correctly identified changed outfits.

		Frequency	Percentage
Outfit 1	Correct	16	27.6
	Incorrect	42	72.4
Outfit 2	Correct	15	25.9
	Incorrect	43	74.1
Overall Correctly Identified Outfits	0	31	53.4
	1	23	39.7
	2	4	6.9

Table 7: Means and standard deviations of the number of correctly identified outfits, based on condition.

Condition	Mean	Standard Deviation
Webcam OFF	0.55	0.632
Webcam ON	0.52	0.634

As displayed in figure 18, only 5.2% of all participants correctly identified all six backgrounds. Conversely, 3.4% identified zero backgrounds correctly. The most identified number of correct backgrounds was four, where 27.6% of participants identified four many backgrounds correctly. Overall, the mean number of correct backgrounds identified was 3.16 and the standard deviation was 1.436. When split on webcam conditions, as shown in table 8, the 'off' condition had a lower mean of 2.66 correctly identified backgrounds, whereas the 'on' condition had a higher mean of 3.66. The standard deviation for the 'off' condition was 1.261, compared with the higher figure for the 'on' condition at 1.446.

Actor one and actor two both changed their backgrounds at different intervals during the meeting video. 15.5% of people correctly identified both of actor one's backgrounds (see table 9), whereas only 12.1% of people correctly identified both of actor two's backgrounds. In fitting with this pattern, 20.7% of people did not correctly identify any of actor one's backgrounds, in comparison to the higher figure of 29.3% of people who did not correctly identify any of actor two's backgrounds. Overall, a mean figure of 0.95 of actor one's backgrounds were identified, with a standard deviation of 0.605. In contrast, a mean figure of 0.83 of actor two's backgrounds were identified, with a standard deviation of 0.625. When split based on webcam conditions, the 'off' condition had an average of 0.72 correctly identified actor one backgrounds, which was lower than the overall average. The 'on' condition displayed an average of 1.17 correct actor one backgrounds, which is much more than the alternative condition and the overall average. In terms of actor two, the mean number of correctly identified backgrounds for the 'off' condition was 0.76 which, again, is lower than the overall average. Following a similar pattern, the mean figure for the 'on' condition was much higher at 0.90 (see table 10 for the means and standard deviations on all dependent variables). Out of all the backgrounds, the second background for actor one and the background for actor four were the most successfully identified, with a figure of 70.7% of participants identifying these correctly. The most incorrectly identified background was the first background used for actor two, where 84.5% of people got this incorrect. This figure for incorrect identifications is much higher than the incorrect figure for the other backgrounds.

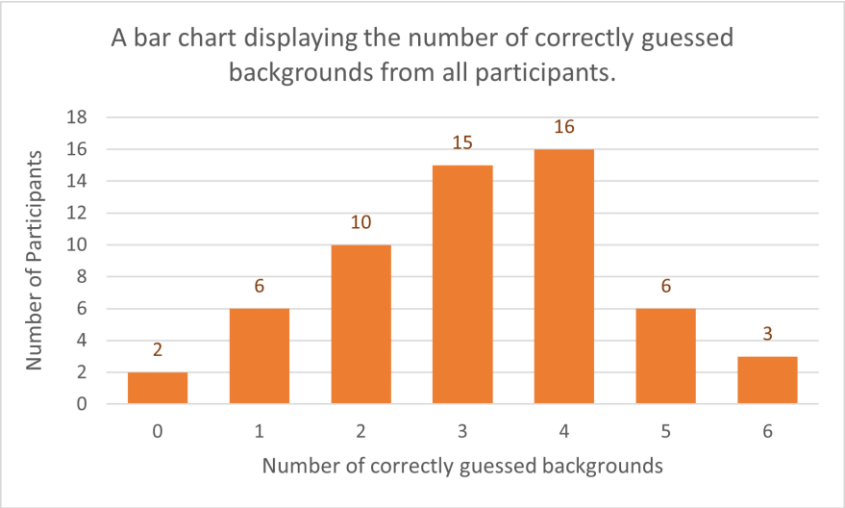

Figure 14: The number of correctly identified backgrounds across all participants.

Table 8: Means and standard deviations for the number of correctly identified backgrounds, based on condition.

Condition	Mean	Standard Deviation
Webcam OFF	2.66	1.261
Webcam ON	3.66	1.446

Table 9: Frequency and percentages of specific correctly identified actor backgrounds, including those that changed.

		Frequency	Percentage
Actor 1 Backgrounds Correctly Identified	0	12	20.7
	1	37	63.8
	2	9	15.5
Actor 2 Backgrounds Correctly Identified	0	17	29.3
	1	34	58.6
	2	7	12.1
Actor 1 (1st Background)	Correct	14	24.1
	Incorrect	44	75.9
Actor 1 (2nd Background)	Correct	41	70.7
	Incorrect	17	29.3
Actor 2 (1st Background)	Correct	9	15.5
	Incorrect	49	84.5
Actor 2 (2nd Background)	Correct	39	67.2
	Incorrect	19	32.8
Actor 3 Background	Correct	39	67.2
	Incorrect	19	32.8
Actor 4 Background	Correct	41	70.7
	Incorrect	17	29.3

Table 10: Summary of the means standard deviations for the three primary dependent variables.

	Mean	Standard Deviation
Correct Names	2.71	1.377
Correct Outfits	0.53	0.627
Correct Backgrounds	3.16	1.436

After these descriptive statistics had been calculated, parametric assumptions for the data were tested. The first parametric assumptions that were tested was tests of normality using a Shapiro-Wilk test on all dependent variables. All the significance values for the Shapiro-Wilk test were $p < 0.05$, where most were $p < 0.01$, displaying that the data was not from a normally distributed data set. Since the first assumption of parametric statistical testing had failed, non-parametric statistical tests were carried out on the data. Histograms were produced of the dependent variable data for each condition to determine which form of Mann-Whitney U test was to be carried out. This determined whether the median ranks would be analysed in the Mann-Whitney U test, if the histograms followed a similar shape, or the mean ranks, if they did not. The histograms produced different shapes, an example being shown in figure 19, and therefore the mean ranks were analysed by the Mann-Whitney U test.

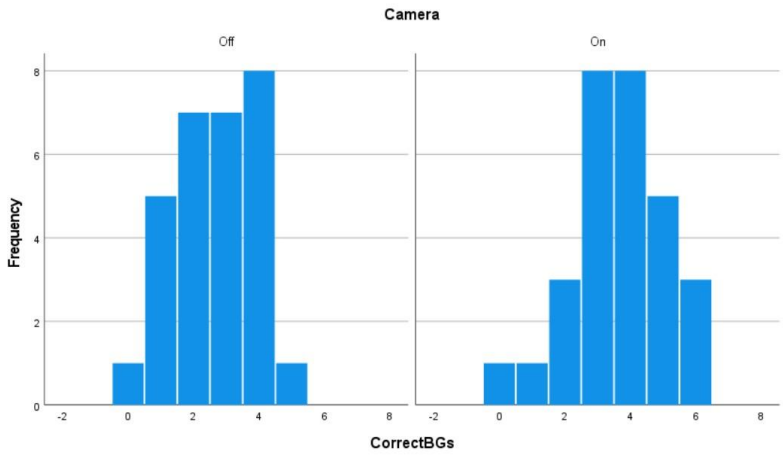

Figure 15: A histogram comparing the general distribution curves across the two conditions for the correct backgrounds dependent variable.

3.2.2. Mann-Whitney U Test

The non-parametric Mann-Whitney U test was conducted on the variables: correct names, correct outfits, correct backgrounds, correct actor one backgrounds, and correct actor two backgrounds. This was conducted to assess whether there was a significant difference in these measures between the webcam on and webcam off conditions. These analyses found there to be no significant difference between the webcam being on or off and correct names ($U = 394.5$, $p = .671$), correct outfits ($U = 407$, $p = .813$), and actor 2 backgrounds ($U = 377$, $p = .441$).

However, a significant difference was found between the webcam conditions and the number of correct backgrounds identified ($U = 255$, $p < 0.01$). These results displayed that individuals with their webcam on identified significantly more backgrounds correctly than those with their webcam off. A further significant difference was found between the webcam conditions and the

number of actor one backgrounds correctly identified (U = 266.5, p < 0.01). These results mean that people with their webcam on identified the backgrounds of actor one significantly more successfully than those with their webcam off. The same cannot be said for actor two. In exploring the data in more depth, a further significant difference was found. Amongst groups who did and did not successfully recall the changed name, there was a significant difference in the number of correct names identified (U = 225.5 , p = .012). This means that those who successfully recalled the changed name also identified significantly more correct actor names.

It was quickly realised that the correct names results were invalidated by those who knew the actors in real life. Therefore, for the final Mann-Whitney U test of difference regarding correct names, the 12 actors who stated that they knew the actors in real life were temporarily removed from the analysis. This, luckily, left an equal number of 23 participants in each webcam condition and 46 participants overall. Even with this data removed, no significant difference was found between webcam condition and correct names identified (U = 249, p = .724).

3.2.3. Spearman's Rank Correlation Coefficient

The non-parametric statistical test of correlation was used to build on the significant differences found from the Mann-Whitney U results, as well as others. This was done on the interval or ratio variables of the data. The first correlation that was analysed was between correct backgrounds (the significantly different result from the previous test) and both the interest rating and difficulty to concentrate rating of the participants. There was no significant correlation found between correct backgrounds and the interest rating (r_s = .059, p = .662), nor the difficulty to concentrate rating (r_s = .062, p = .642). A further test of correlation was then conducted on the interest rating against the difficulty to concentrate rating directly, and a moderate, negative correlation was found between the two and this was statistically significant (r_s = -.445, p < 0.001). This means that there was a correlation between how interesting participants found the meeting and how difficult participants found it to concentrate on the meeting, shown in figure 20.

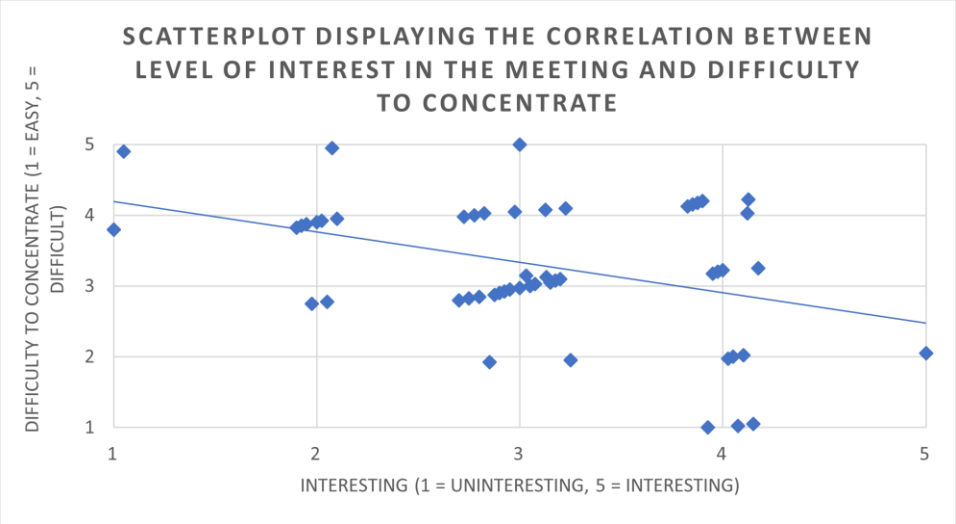

Figure 16: The correlation between level of meeting interest and difficulty to concentrate.

A further statistical correlation test was carried out to assess a potential correlation between correct backgrounds identified and the time the experiment was completed at. Time here was recorded in a hh:mm:ss format. This test displayed a moderate, negative correlation between the two and it was statistically significant (r_s = -.415, p = 0.001). This displays that later times of completion is correlated with less correct backgrounds identified. This correlation is displayed in figure 21. To further investigate the concept of time passing, a test was carried out to assess a

correlation between time of experiment completion and interest rating and difficulty concentrating, respectively. There was no significant correlation found between time of completion and interest rating (r_s = -.082, p = .539), nor the difficulty to concentrate rating (r_s = -.059, p = .659).

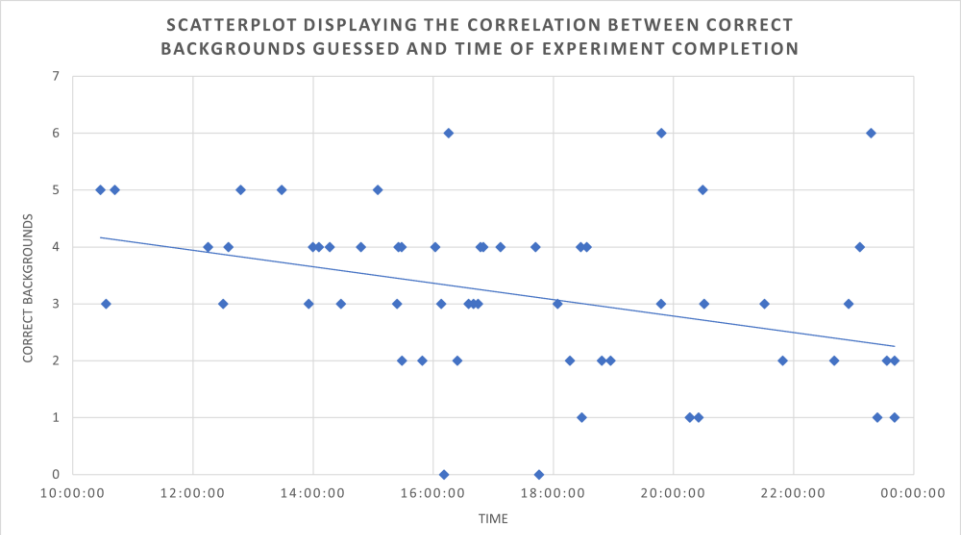

Figure 17: The correlation between correct backgrounds identified and time of experiment completion.

3.2.4. Chi-squared Test

A final statistical non-parametric Chi-squared test was carried out on two variables to assess any significant differences between the two, which was used due to the measured variable being of a nominal data type. This test was done between webcam conditions and successful recollection of the name change. However, there was no significant difference between those with their webcam off or on and their success in recalling the changed name (x^2 = 1.957, p = 1.62).

3.2.5. Critical Evaluation and Discussion

Overall, these results showed that there was a significant difference between people who had their webcam on and off, and the number of backgrounds correctly identified. There was also a significant difference found between people who had their webcam on and off, and their success in identifying both of actor one's backgrounds. A further significant difference was found between people who successfully and unsuccessfully recalled the actor's name change, and the number of names correctly identified. Two significant correlations were also discovered during the course of this research. The first significant correlation was between the rating of how interesting participants found the meeting and how difficult participants found it to concentrate on this meeting. The second significant correlation was between the number of backgrounds correctly identified and the time the participant finished the experiment. The remaining differences and correlations tested were found not to be significant.

The first significant difference between people who had their webcam on and off and number of backgrounds correctly identified is a very distinctive finding. This implies that there is some impact by having a webcam turned off that makes participants less likely to correctly recall the actor backgrounds. This early finding can act as platform for future research in this space, where the specific consequences of having a webcam turned off can be identified. A possible hypothesis to be tested in this area is whether having one's webcam turned on makes participants more attentive to the visual aspects of the meeting, for example someone's background.

Remarkably, the second significant difference found was in the success of actor one's backgrounds identified, but this did not have the same influence in actor two. This could be attributed to a few potential reasons, one of these being the placement of the actor's webcams or the amount of time each actor spoke for. Actor one was placed in the top left corner of a 3 by 2 grid, and actor two was placed in the top centre space. Additional investigation could examine whether webcam spacing has an effect. Attention could also be pointed towards the specific content of the backgrounds. Actor one's first background was in a vivid and colourful but overcast field (the background images are present in the appendix of this report), and their second background was inside the sunny living room of a house. Actor two's first background was in a bright office with an overlooking view of nature, and their second background was on a beach. For both actors, the second background was correctly identified by many more participants than the first. The first background for actor one was selected more than the first background for actor two, and this trend was identical for both second backgrounds. This was an unforeseen finding as it was assumed that the more salient background, i.e. the beach, would be chosen more frequently than the other less salient backgrounds, i.e. the offices and houses. Though, this could be attributed to order effects. Actor one replaced their background a few minutes before actor two, and therefore actor one's new background may have been more salient than actor two's background for this reason. People may not have anticipated an additional background change after this and may have still been focused on the first one.

The third significant difference was more expected, between the people who successfully and unsuccessfully recalled the actor's name change and the number of names correctly identified. This finding cannot be attributed to webcam differences as the statistical test between the webcam conditions and correct names was non-significant, but it could simply be recognized as individual differences in ability to recognise and recall different names. One factor that may affect the validity of this result is the experience of the participant. For example, those in education and those whose work does not require use of meetings or meeting various new people may not be required to remember new names immediately. Alternatively, people whose work requires them to regularly attend meetings with new people, particularly in client-facing and consultancy roles, may place more importance in recalling names. Consequently, these people may be naturally more skilled in this field, and this may not be representative of the participants but of their career. Upon reflection, a question examining the specific job role of the participant may have been of value in this experiment.

The first significant correlation found was another anticipated finding, between the participant's rating of how interesting they found the meeting and how difficult they found it to concentrate throughout the meeting. Naturally, the more interesting participants found the meeting, the easier they found it to concentrate. Yet again, this could be grounded in the experience of the participant where those more familiar with virtual meetings may have naturally found more interest in the meeting and the topic, which surrounded the future of work and education after COVID-19. The question asking people whether they were able to work or study online during the height of COVID-19 was considered to be analysed against these scores, but the responses were extremely unbalanced. Out of the 58 respondents, 82.8% of these said that they were able to work or study at home throughout COVID-19, 12.1% said they were not and 5.2% said that this question was not applicable to them. These unbalanced answers, as a result, were not assessed for a correlation against the interest and difficulty to concentrate ratings. Interestingly, there was no significant correlation found between either of these ratings and number of backgrounds correctly identified, implying that such attention and recall was similar in both people who were interested and uninterested in this experiment. However, a validity issue arises where people may have instinctively paid more attention to this meeting because the experimenter, who knew them personally, asked them personally to participate and this may be susceptible to some degree of sentiment. In a real meeting, the same attention may not be paid because of different contexts and attending the meeting may simply be a requirement of their work or educational institution. Thus, it could be of value for this experiment to be double-blind in the future.

The final significant correlation was one that was largely unexpected, between the number of backgrounds correctly identified and the time the experiment was completed at. This measure of

time was automatically calculated by Google Forms itself and not by the experimenter. However, the chance that this could have some effect was considered and the measure was therefore included in the analysis. This result implies that, the later the time of completion is, the less probable the participant is to correctly identify the backgrounds of the actors. This requires further investigation and could simply be attributed to the energy levels of the participants. Naturally, energy levels fall throughout the day and this could lead to less attention paid during the meeting or deteriorated ability to recall the information. After this correlation was found, the time measure provided was analysed further for its descriptive statistics. The mean time this experiment was completed at was 17:26:44. The earliest experiment completion time was at 10:27:38, and the latest experiment completion was at 23:40:49. Three individuals completed this experiment in the morning (before 12pm midday), 30 individuals completed it in the afternoon (from 12pm midday to 6pm), and the remaining 25 participants completed the experiment in the evening (after 6pm). This may have had heightened influence on the results since meetings typically occur during the working day from the hours of 9am until 5pm. Given that the mean completion time in this experiment was outside of these hours, the results may not be entirely representative of people who usually attend meetings. Attending meetings outside of these times may affect the participant differently and lead to different rates of attention and recall and therefore, if this experiment was to be replicated in the future, it may be beneficial to limit the experiment completion times to between specific hours of the working day. Additionally, whilst it is unknown specifically how many, several participants completed this experiment on the weekend which, again, is not characteristic of meetings and may not fully representative of those who attend these.

Curiously, there was no significant correlation found between webcam condition and successful recollection of the name change. This finding is not fitting with the previously considered idea that those with their webcam off may feel less inclined to pay attention to visual features of the meeting, since the name change was not verbal but only visual. Similarly, there was no significant difference found between webcam conditions and the number of names correctly identified, which indicates that the webcam has no effect on noticing such factors.

Certainly, the form of the meeting itself had some flaws that may have affected the validity of the results. Due to tight time constraints and availability of the participants, the meeting had to be pre-recorded and 10 minutes in length was deemed to be sufficient. Whilst this was appropriate for this experiment, further investigation may have to readapt this experiment in a more organic setting. For example, 10 minutes may not be long enough to simulate a conventional meeting and therefore participants may behave slightly differently to how they would otherwise. Also, whilst fitting for this experiment, the meeting being pre-recorded has its shortcomings. For example, this does not allow the participant to fully engage with the other individuals in the meeting as they would in a typical meeting, which may lead to less engagement and therefore less attention paid in the meeting. This concept may make the results susceptible to the same ideas presented in the literature review of this paper, where disengagement leads to low levels of group belongingness, which in turn can lead to elevated levels of meeting fatigue and, hence, full attention may not be paid. High meeting fatigue in conjunction with later times of experiment completion may make the participant unable to perform to the best of their ability. Furthermore, because the participant knew they were not required to actively participate at any point, they may have felt little point in considering such specifics. Conversely, it was unfeasible in the first iteration of this experiment to request so much of coursemates' time to present this meeting live per person for 50 participants, especially with restricted time to complete the report. The live meeting would mean participants observe a slightly unique version of the meeting every time, raising reliability issues.

Likewise, the context in which these participants completed the meeting were different to meetings they may frequently partake in. For example, participants generally know who will be present in a meeting, know the reason for a meeting, may wear a particular attire, among many other factors. Yet, the participants in this experiment were mindful that the reasoning for the meeting was for experimental purposes and, from comments received after completion of the experiment, a few individuals had successfully worked out the intentions of the experiment. Some participants provided additional comments, stating that once they had noticed one change (the first change being

actor one's background), some had either realised that the experiment was about change blindness and therefore actively looked out for more changing features, or some did not know the subject but looked out for more changed elements anyway. Some participants in the experiment studied degrees such as psychology, and therefore a few participants were conscious of the concept of change blindness and immediately realised the aim of the experiment.

One facet of the meeting that may have attracted more attention to the changed features than desired is the fact that the video often froze for around three seconds. This was a mandatory feature as it was regarded the only way that two separate clips could flow into each other without jumping too much, making it seem like the most natural solution possible. However, it may have been apparent to participants that this is not a typical feature in a pre-recorded video, and they therefore might have been more aware of modifications through this unexpected occurrence throughout the video.

There were some further implications that the structure of the post-meeting questionnaire may have had. One major issue with this, which was reported by a participant after their completion of the experiment and overlooked by the experimenter during creation of the questionnaire, regarded the structure of the questionnaire. There were three sections of the questionnaire, excluding the introductory section. The first segment asked general and brief information about the participant, the second section asked about brief opinions of the meeting content and to summarise this, and the third question contained the specific measures of the experiment and asked the participant to recall various factors. However, as this participant stated, asking an individual to recall the changed factors at the *end* of the questionnaire rather than at the beginning or in middle could theoretically be representative of long-term memory, since some information may have decayed by this point [29]. After this feedback was received, further analysis was conducted on the responses to these two text-based questions, which were previously considered to be of less value to this experiment. For the question asking for a brief meeting summary and for the question asking for the summarised participant opinion on the meeting, the difference between the highest and lowest word counts were calculated. For the first question, there was a word count difference of 63 words and, for the second question, this difference was higher at 366 words. This perfectly displays the difference in time different participants spent on this second section of questions, meaning that, for these people, their recall may have been affected by this. As a result of this awareness, further analysis was done on these four participants (those with the highest and lowest word count in each of the two questions). A summary of these participants and their respective results is shown below in table 11.

Table 11: A summary of the highest and lowest word count participants for each question.

Question	Word Count for Q	Time	Webcam?	Correct Names	Recall Name Change	Correct Outfits	Correct Backgrounds
Summary of the meeting topic.	64	23:23:48	Off	1	No	0	1
	1	20:30:46	Off	4	No	0	3
Summarised opinions on the meeting topic.	367	19:47:59	On	1	Yes	1	6
	1	14:27:46	On	4	No	0	3

This summary fits with the earlier theory that leaving more time between the end of the meeting and recalling it can cause recall to somewhat diminish. However, this only seems to be a suitable theory for the correct names, but not for the other factors. The two individuals with the highest word count both identified one name correctly, but the two individuals with the lowest word counts identified all four names correctly. This would require further testing to evaluate whether the correlations between these two factors are of any significance.

4. General Discussion

4.1. Reflections on the Experimental Results and Development Process

The biggest achievement of this experiment is its modest contribution to rather sparse literature on the topic of virtual meeting science and the nature of videoconferencing by examining its specific components. Being an area of expertise which has suddenly increased in relevance after the COVID-19 pandemic has meant that such knowledge is invaluable to forming the most helpful and efficient meetings possible. This may be of particular benefit to workplaces where meetings are the primary mode of work, and to educational institutions to maximise employee and student performance. To the understanding of this study, change blindness has not yet been investigated in a meeting, nor videoconferencing, setting and this experiment has shown that there are changes in these frameworks during periods of full attention where changes can still go undetected.

This experiment has acknowledged that there is some form of variance between those with their webcam on and those with their webcam off, implying that the current practise of people freely deciding during meeting to have their webcam on or not may not be the optimal method for productivity. This has opened up many areas to be questioned and calls for further investigation on these areas, but has acted as a platform for such future experimentation by providing some early conclusions about the attention levels in these groups. This paper has also been successful in identifying some extraneous factors which were not previously anticipated, for example the factor of time having an impact. Currently, meetings are held at all hours of the working day depending on availability, but it may be beneficial from an attentional and recall perspective to hold these earlier in the day. A further achievement of this project has been conforming to the time constraints provided, despite all unforeseen circumstances. Several iterations were made to the original plan for this study, as presented in figure 22, but highly organized time management and comprehensive planning allowed for the study to be finalised to the best of its ability.

<table>
<tr><th>w/c</th><th>plan</th><th>adapted</th></tr>
<tr><td>14th June</td><td>consider idea</td><td rowspan="2">consider idea (changed the idea, therefore needed more time)</td></tr>
<tr><td>21st June</td><td>literature search - web of science</td></tr>
<tr><td>28th June</td><td rowspan="2">make experiment - edit (blender), html, put up on website, make questionnaire (google forms)</td><td rowspan="2">contracted covid - unable to work. some light literature work</td></tr>
<tr><td>5th July</td></tr>
<tr><td>12th July</td><td rowspan="3">hand out experiment (aim: 30 participants) , write method and literature review of report whilst waiting for results</td><td rowspan="2">make experiment - edit (ffmpeg), put on website, make questionnaire. final literature work</td></tr>
<tr><td>19th July</td></tr>
<tr><td>26th July</td><td rowspan="2">bereavement - begin to hand out experiment?</td></tr>
<tr><td>2nd Aug</td><td>analyse experiment results - r / spss</td></tr>
<tr><td>9th Aug</td><td rowspan="3">write remaining report - intro, results. make relevant adaptations to method from before</td><td rowspan="2">hand out experiment (aim: 50 participants - 30 was not enough) write method + lit review</td></tr>
<tr><td>16th Aug</td></tr>
<tr><td>23rd Aug</td><td>analyse results - spss</td></tr>
<tr><td>30th Aug</td><td>details of report - format, abstract, etc...</td><td rowspan="3">write remaining report - intro, results. make relevant adaptations to method from before.</td></tr>
<tr><td>6th Sept</td><td>final checks & changes. hand in</td></tr>
<tr><td>13th Sept</td><td>DUE</td></tr>
<tr><td>20th Sept</td><td></td><td>format. final checks & changes</td></tr>
<tr><td>27th Sept</td><td></td><td>DUE</td></tr>
</table>

Figure 18: Original overall plans for completing the report, with changes made along the way.

Though, the experiment is not without its weaknesses and there are several deficiencies that occurred throughout this project that would need to be rectified upon future replication of this experiment. The positioning of the recall related questions at the end of the questionnaire, for

example, was ultimately an error. This should have been placed at or near the beginning of the questionnaire for the most accurate representation of recall in this data. In hindsight, a question in this questionnaire should have inquired as to what the job role of the participant was and if they were in education. This would have more precisely assessed how strong their familiarity with meetings was and knowing their field of study may have allowed filtering of the participants who had heightened knowledge of change blindness (so they were unable to predict the experiment aims). Equally, a question should have been raised regarding whether they had anticipated the aims of the experiment at any point during the meeting, or if they were completely unaware until beginning the questionnaire. Unfortunately, and due to time constraints, many questions have yet to be answered. For example, for what reason did participants remember significantly more of actor one's backgrounds than actor two's? Also, why did time lead to worse background recall, but not for other factors? After further forthcoming experimentation, it would be particularly interesting to see if this has links to concepts of meeting fatigue as mentioned in the literature review of this report. This is all in addition to the potential validity issues assessed during the critical evaluation of the results.

4.2. Next Steps

With more time to study this topic, the primary change would be to execute the virtual meetings live and for longer than 10 minutes. Whilst this method was the most appropriate for the current study and there would be remain flaws to be considered with a live meeting, it may be advantageous to analyse results where the participant has the opportunity to take a more active role in the meeting, as well as being interactive with the actors. It may be equally as interesting to compare results where participants were not active in the meeting (i.e. the current experiment), with a meeting where they were. These findings may be indicative of the effects of group belonginess and, as mentioned previously, the fact that active participants have been found to experience lower meeting fatigue. With more time, a comparison group of in-person meeting participants would have been established as a control group. This would make the changes between in-person and virtual meetings more salient and allow for issues to be identified between the two when compared directly. Furthermore, it would have been of exceptional value to hold some in depth interviews with participants to build on the general comments received after participation. This would evaluate their opinions on having their webcam on versus having it turned off, evaluating optimal work environments and contexts, and changes they may like to see in virtual meetings. To add to this point, extra measures could be embedded into the questionnaire, for example asking how much the participant thinks they looked at themselves, as well as how they rated their fatigue levels throughout the meeting. Rating fatigue levels would be very indicative of meeting fatigue and of the factors that can affect this. If this experiment were to be repeated, different backgrounds could also be assessed for the purposes of assessing reliability and consistency to gather more data. One factor that could increase the validity of the results would be to control for group belongingness and social group, based on the previously mentioned studies by Bennett and Campion (2021) [3].

Focussing specifically on the outcomes of this experiment, no firm suggestions can be made about the future of videoconferencing as this paper provides only the first iterations for an assortment of studies about videoconferencing components. Firm recommendations would be formed with rigorous further research about the topic, as well as replications conducted of the current experiment.

5. Conclusion

The primary aim of this report was to investigate whether there is an attentional difference in groups who have their webcam on in a videoconferencing setting, in comparison to those who have their webcam off. This experiment met this objective, identifying a significant difference

between those who had their webcam on and those who had their webcam on and how many backgrounds they correctly identified from observing a meeting. This change blindness measure is an indication of the amount of attention paid by the participant, but also their ability to recall this data. This experiment successfully demonstrated that having a webcam on or off yields different performance results of the participant during the experiment, and this should therefore be considered when attempting to maximise student or worker performance. It also identified a significant difference between the number of changed backgrounds identified for one actor, but not another actor. The reasoning for this continues to be unknown and, whilst theories can be postulated, any concrete conclusions would involve further experimentation.

A secondary aim of this report was to delve into any extraneous factors which could theoretically impact these attentional differences further. The results of this experiment also recognized a significant difference between people who successfully and unsuccessfully recalled an actor's name change, and the number of names correctly identified. Since the measure of correct names was not significant against the webcam conditions, this must be attributed to other factors or this could be a measure of individual differences. A further significant extraneous factor identified was exhibited in the significant correlation between the number of backgrounds correctly identified and the time participants finished the experiment. This displays that time has some effect on attention and recall in participants and therefore, according to these results specifically, holding meetings earlier would maximise attention and recall, potentially due to the time of lowest mental and meeting fatigue. Another significant correlation was found between the rating of how interesting participants found the meeting and how difficult they found it to concentrate, but this did not significantly correlate with correct answers on any measure. This implies that interest levels yielded similar attention and recall rates regardless.

A further aim of this report was to contribute to the sparse literature on videoconferencing meetings with an overarching goal of enhancing the future of videoconferencing. This investigation has added to knowledge of the specific videoconferencing component: the webcam. One of the greatest issues identified in this report was, not only the sparse literature in this area, but that virtual meetings do not perfectly replicate in-person meetings and the current state of videoconferencing is not adequate. This insufficiency is clear in previously mentioned statistics involving mental health complications, lack of body language communication, potential biases towards in-person workers, meeting fatigue, and many more.

Whilst one clear solution cannot yet be offered to fix the modern world of remote meetings, this experiment acts as a platform for others to build on towards filling gaps in the literature. Once it can be identified where issues, such as virtual meeting-induced bias and meeting fatigue, arise from through comparable experiments, these can be rectified or mitigated to ultimately create a more natural, efficient and comfortable videoconferencing environments.

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Appendix A

The GitHub repository for this project can be found at the link below:

https://github.com/kiran-nicole-rai/kiran-nicole-rai.github.io

In this repository, you will find the following files:

File	Description
dev (folder)	Various scripts used in the development of the project assets. Important Note: these scripts were used during development and are *not* required for the running experiment.
docs (folder)	Various documents in relation to the project. This includes the final project report.
index.md	The main landing page for the experiment.
meeting-1.html	The webpage for the 'webcam ON' condition of this experiment.
meeting-2.html	The webpage for the 'webcam OFF' condition of this experiment.
PROJECT_CAMERA_OFF.mp4	The video file used for the 'webcam OFF' condition.
PROJECT_CAMERA_ON.mp4	The video file used for the 'webcam ON' condition.
README.md	Basic information about the contents of the repository.
LICENSE	Project license file.

The code for this project is automatically deployed and running at the following GitHub Pages site:

https://kiran-nicole-rai.github.io/

If anyone wants to run this code outside of GitHub Pages, they simply need to download the files in the project root directory and place these into the root directory of any webserver, such as Apache. Note: index.md may first need to be rendered into its HTML form.

Appendix B

OYIN

HIMAAS

PRAB

ISAAC

LINE 1 **Oyin – Hi guys… Is everyone here? Can everyone hear me?**

LINE 2 **Himaas / Prab / Isaac – Yeah, I can hear you.**

LINE 3 **Oyin – Ok, perfect. So, we have a few guests joining us in our meeting today so hello to all of you!**

LINE 4 **Himaas / Prab / Isaac – Hi guys!**

LINE 5 **Oyin – To our guests, you guys will be listening in to this meeting and then we will ask you a few questions at the end. So, my name is Oyin!**

LINE 6 **Himaas – Hi everyone, my name is Himaas.**

LINE 7 **Prab – I'm Prab.**

LINE 8 **Isaac – And my name is Isaac! We are all studying at postgraduate level at the University of Birmingham and this meeting is primarily to discuss the future of studying and working after coronavirus is over.**

LINE 9 **Prab – It's really interesting because I actually studied at Uni of Birmingham for my undergraduate degree, but everything was completely different then. You would HAVE to come onto campus every single day you had teaching and sit in a lecture theatre full of hundreds of students.**

LINE 10 **Himaas – Exactly … whereas now we can study at Uni of Birmingham whilst living in a completely different country! All of the lectures and exams being online this year has definitely changed everything.**

LINE 11 **Isaac – Yeah … I heard talks about teaching moving to a permanently hybrid system of both online and in person lectures even after coronavirus is over.**

LINE 12 **Oyin - There was a really insightful research report published this year by the McKinsey Global institute. One of the most significant findings they reported was that, by 2030, 17 MILLION workers may need to change occupations in the US alone.**

LINE 13 **Prab / Himaas / Isaac – Wow / That's crazy**

LINE 14 **Prab – And changing entire occupations means reskilling all of those 17 million people which is going to be so time consuming.**

LINE 15 **Isaac – Exactly. Forbes also published an online article about the future of work post-covid, where they described the acceleration of three main trends. The first one was that there is going to be a greater reliance on remote work, and so virtual meetings will become more common and travelling will become less common.**

LINE 16 **Himaas – That is really interesting and we can already see that change happening in our education. There seems to be a lot less need to be physically present, when you can be just as productive, if not more, in your own home.**

LINE 17 **Oyin – True … that also cuts out travelling time which gives people more time to be productive. I imagine this would raise morale too, especially if workers feel more well rested before work. Dell actually reported that there was an annual saving of 350 dollars per year for employees who worked remotely 33% of the time!**

LINE 18 **Prab / Himaas / Isaac – Wow! That's a lot.**

LINE 19 **Himaas – Sorry to interrupt guys but my internet isn't very good right now – it might cut out at some point.**

LINE 20 **Oyin / Isaac / Prab – That's okay!**

LINE 21 **Isaac – The second one was increased use of e-commerce and virtual transactions like restaurant delivery or online shopping.**

LINE 22 **Prab – that makes sense. I guess that links to the previous point of people changing occupations because there will be less need to have workers physically present in shops.**

LINE 23 **Oyin / Himaas – Yeah, I agree.**

LINE 24 **Isaac – The last one was that there will be a greater adoption of automation.**

LINE 25 **Himaas – Ahh, yes. That definitely links to the increased use of e-commerce because warehouses would have needed to increase automation to cope with higher volumes of e-commerce. Especially when things like toilet rolls, masks and electronics were in such high demand!**

LINE 26 **Oyin – And pasta!**

LINE 27 **[LAUGH AT THAT BIT LOL]**

LINE 28 **Oyin – This complete workforce shift is definitely something that only happens once in a lifetime. There are definitely pros and cons to this shift.**

LINE 29 **Prab – Definitely. Seeing people face to face is really good for building genuine relationships and it means you can get a proper work / home separation. But the thing is, not everyone defaults to office work patterns. Now we have experienced the new virtual work pattern, not everyone can be expected to fall into just one of these.**

LINE 30 **Isaac – Yeah, exactly. IBM are doing an ongoing study on 54,000 people from the US and they found that only 8% wanted to work exclusively at their workplace. 39% wanted to work exclusively remotely and 45% wanted a mix of both.**

LINE 31 **Oyin – That is definitely something to think about. To the guests in this meeting, consider whether you think the future of work should be exclusively remote, exclusively in the workplace, or a mixture of both. Try to consider why you have that opinion, and we will ask you to explain this a bit further at the end.**

LINE 32 **Himaas – Personally, I think the choice of both would be best. Giving people the choice can also combat the issue of loneliness with remote working. The same IBM study described that 1 in 4 workers have experienced mental health impacts such as feelings of loneliness, isolation, and lack of motivation because of solely remote working.**

LINE 33 **Oyin – I think this shift would definitely benefit workers. But it would also benefit companies too! Dell also reported annual savings of 12 million dollars are reducing their number of lease agreements during the height of remote working. So much money can be saved on office space, as well as significantly broadening the talent pool to people everywhere!**

LINE 34 **Prab – Yeah, that is so true! It's a difficult situation because there is not just one solution to fit every single worker. For exclusively remote workers, it can be quite difficult to form bonds with managers and seniors, which could cause unintentional bias when it comes to appraisals and promotions!**

LINE 35 **Isaac – I agree. There was an influential article written by Elsbach in 2010 which researched how 'passive facetime' affects the perception of employees. Passive facetime is the amount of time someone is passively observed without direct interaction, for example, sitting at your desk when a senior walks by or chatting with a co-worker across the room. They found that managers unintentionally use this to assess work contributions of employees, unfortunately.**

LINE 36 **Himaas – This is could definitely be a huge disadvantage for remote workers. They also found that people who experience more passive facetime with their seniors are more likely to be called 'committed' and 'dedicated'.**

LINE 37 **Oyin – An organisation called FutureStep actually did a poll on this where they spoke to 1320 global executives in 71 countries. They found that 61% of senior managers think that telecommuters are not as likely as conventional office workers to be promoted. That is an astounding figure!**

LINE 38 **Prab – If we were to allow both office workers and remote workers, these things would definitely have to be considered and a lot of changes would have to be made.**

LINE 39 **Isaac / Himaas / Oyin – Yeah, I think so too.**

LINE 40 **Oyin – Okay everyone, I think that concludes our meeting now. I would like to thank Prab, Himaas and Isaac for their time to discuss these issues. I would also like to thank the guests in our meeting and I hope you found this somewhat interesting!**

LINE 41 **Prab – Thanks Oyin and thank you all for your time. So, to the guests in our meeting … you will now be asked some questions about the meeting. And to everybody else, goodbye!**

LINE 42 **Oyin / Isaac / Himaas – Thanks everyone, see you later / bye!**

Appendix B: Meeting script.

Appendix C

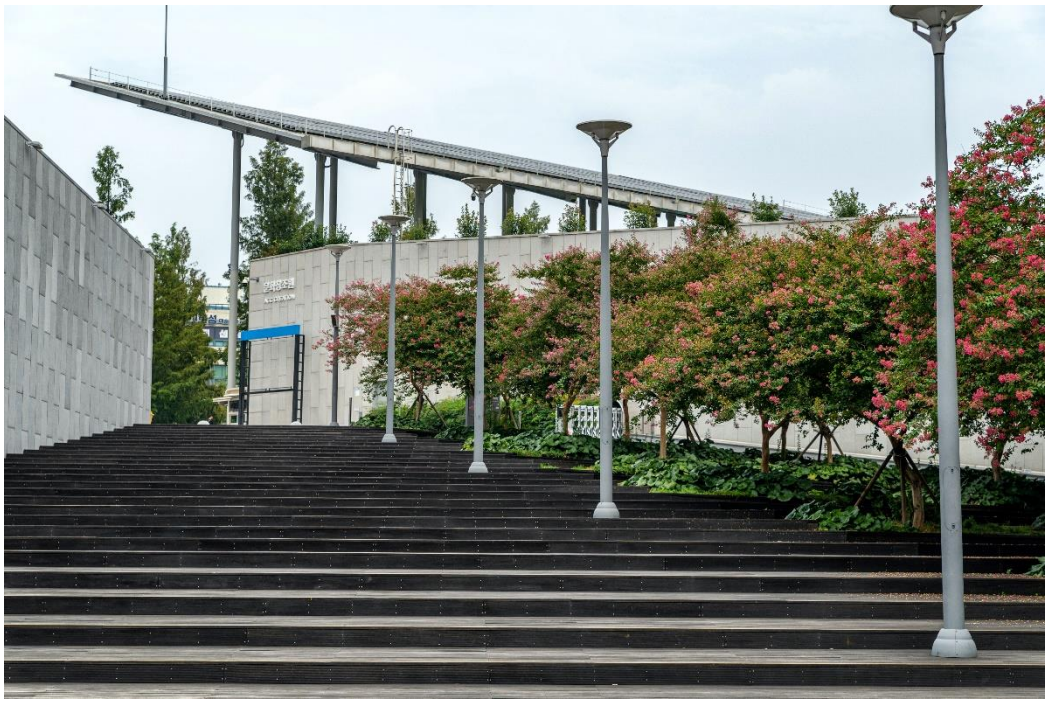
Appendix C: Actor one first background.

Appendix C: Actor one second background.

Appendix C: Actor two first background.

Appendix C: Actor two second background.

Appendix C: Actor three background.



Appendix C: Actor four background.

Appendix D

Post-meeting Questions

The final stage of this experiment requires answering a short questionnaire, comprised of three sections, regarding the meeting you just watched.

This study will contribute to research on the future of video conferencing and therefore please ensure you answer all questions honestly without referring to the meeting. All responses will be confidential and any data will be strictly used for research purposes. If you have any questions, please feel free to text or email me at knr756@student.bham.ac.uk.

Sign in to Google to save your progress. Learn more

Next Clear form

About you...

What is your age? *

- ◯ Under 18
- ◯ 18-24
- ◯ 25-34
- ◯ 35-44
- ◯ 45-54
- ◯ 55+
- ◯ I prefer not to say.

Were you able to work or study from home during the height of COVID-19? *

- ◯ Yes
- ◯ No
- ◯ N/A
- ◯ I prefer not to say.
- ◯ Other: _____

Do you know the participants in this meeting in real life? *

- ◯ Yes
- ◯ No
- ◯ I prefer not to say.
- ◯ Other: _____

Was your webcam on or off during this meeting? *

- ◯ On
- ◯ Off
- ◯ I don't remember.

Back Next Clear form

What are your opinions about the meeting?

Please answer the following questions as best you can. There are no right or wrong answers.

Please give a short summary of what you believe the meeting was about. *

Your answer

What are your opinions on studying and working in an office job post-covid? Do you think such work should be exclusively remotely (i.e. always working from home), exclusively back in person (i.e always working in the office), both, or neither? Please summarise this. *

Your answer

Please state how interesting you found this meeting. *

	1	2	3	4	5	
Extremely uninteresting.	◯	◯	◯	◯	◯	Extremely interesting.

Please state how difficult you found it to concentrate throughout this meeting. *

	1	2	3	4	5	
I found it very easy to concentrate.	◯	◯	◯	◯	◯	I found it very difficult to concentrate.

Back Next Clear form

What do you remember about the meeting?

Please answer the following questions as best you can from memory.

In the meeting, what was the name of participant 1? If you do not know, please write 'I don't know'. *

Your answer

In the meeting, what was the name of participant 2? If you do not know, please write 'I don't know'. *

Your answer

In the meeting, what was the name of participant 3? If you do not know, please write 'I don't know'. *

Your answer

In the meeting, what was the name of participant 4? If you do not know, please write 'I don't know'. *

Your answer

In the meeting, what was the name of the guest with their camera off? If you do not know, please write 'I don't know'. *

Your answer

Over the course of the meeting, do you recall any participant changing their name? *

- ◯ Yes, and I remember what it changed to.
- ◯ Yes, but I don't remember what it changed to.
- ◯ No
- ◯ Maybe
- ◯ Other:

If you answered 'Yes, and I remember what it changed to.' in the previous question, please state the original name of the participant AND what you believe it changed to. Otherwise, please write 'I don't know'. *

Your answer

Which outfit do you recall seeing participant 2 wearing? Please select any that you recall seeing. *

☐ Outfit 1

☐ Option 2

☐ Outfit 3

☐ Option 4

☐ Outfit 5

☐ Outfit 6

☐ I don't remember seeing any of these.

Which of these backgrounds do you recall seeing? Please select all that apply. *

☐ Background 1

☐ Background 2

☐ Background 3

☐ Background 4

Background 5

Background 6

Background 7

Background 8

Background 9

Background 10

Background 11

Background 12

I don't remember seeing any of these.

Back Submit Clear form

Post-meeting Questions

Thank you for your participation in this experiment! If you are interested in what this study was investigating, please read on. Your time and effort has been greatly appreciated.

The aim of this study was to assess whether attention levels in video conferencing settings are influenced by a concept known as the 'all day mirror'. As described by Jeremy Bailenson, the 'all day mirror' is the idea of seeing your own image throughout virtual meetings, something that does not occur in in-person meetings. Attention levels in this experiment were measured using a phenomenon called 'change blindness'. This is something that occurs when a visual stimulus undergoes a change and this change is not noticed by its observer. In this experiment, some changed details included: participant names, participant clothing, participant backgrounds, etc.

Therefore, this experiment will analyse whether there is a significant difference in attention levels amongst participants who could see their own image vs participants who could not see their own image.

Submit another response

Appendix D: Questionnaire.

Appendix E

Test Statistics[a]

	CorrectNames	CorrectOutfits	CorrectBGs	HimaasBGs	OyinBGs
Mann-Whitney U	394.500	407.000	255.000	266.500	377.000
Wilcoxon W	829.500	842.000	690.000	701.500	812.000
Z	-.425	-.237	-2.634	-2.807	-.770
Asymp. Sig. (2-tailed)	.671	.813	.008	.005	.441
Exact Sig. (2-tailed)	.691	.909	.008	.007	.513
Exact Sig. (1-tailed)	.345	.454	.004	.004	.257
Point Probability	.007	.094	.000	.001	.037

a. Grouping Variable: Camera

Test Statistics[a]

	CorrectNames
Mann-Whitney U	225.500
Wilcoxon W	1005.500
Z	-2.525
Asymp. Sig. (2-tailed)	.012

a. Grouping Variable: RecallNameChange

Appendix E: Significant Mann-Whitney U Tests.

Correlations

			Interesting	DifficultyConcentrating
Spearman's rho	Interesting	Correlation Coefficient	1.000	-.445**
		Sig. (2-tailed)	.	<.001
		N	58	58
	DifficultyConcentrating	Correlation Coefficient	-.445**	1.000
		Sig. (2-tailed)	<.001	.
		N	58	58

**. Correlation is significant at the 0.01 level (2-tailed).

Correlations

			CorrectBGs	Time
Spearman's rho	CorrectBGs	Correlation Coefficient	1.000	-.415**
		Sig. (2-tailed)	.	.001
		N	58	58
	Time	Correlation Coefficient	-.415**	1.000
		Sig. (2-tailed)	.001	.
		N	58	58

**. Correlation is significant at the 0.01 level (2-tailed).

Appendix E: Significant Spearman's Rank Tests.

Appendix F

```
<!DOCTYPE html>
<html lang="en">
<head>
  <meta charset="utf-8">
  <meta name=viewport content="width=device-width, initial-scale=1">
  <title>Experiment: Meeting</title>
  <style>

  body {
    overflow-x: hidden;
    margin: 0;
    padding: 0;
    background-color: #444;
  }

  #zoom {
    position: absolute;
    top: 50%;
    left: 50%;
    transform: translateX(-50%) translateY(-50%);
    width: 100%;
    height: 100%;
    min-width: 100%;
    min-height: 100%;
    z-index: 1;
  }

  #camera {
    position: absolute;
    z-index: 2;
    transform: rotateY(180deg);
    -webkit-transform:rotateY(180deg); /* Safari and Chrome */
    -moz-transform:rotateY(180deg); /* Firefox */
  }
```

```
  #intro {
    position: fixed;
    bottom: 0;
    background: rgba(0, 0, 0, 0.5);
    color: #f1f1f1;
    padding: 20px;
    font-family: Arial;
    font-size: 17px;
    z-index: 3;
  }

  #intro a, #intro a:hover, #intro a:visited
  {
    color: #f1f1f1;
  }

  #start {
    width: 200px;
    font-size: 18px;
    padding: 10px;
    position: fixed;
    float: right;
    bottom: 7px;
    right: 20px;
    border: none;
    background: #000;
    color: #fff;
    cursor: pointer;
  }

  #start:hover {
    background: #ddd;
    color: black;
  }
```

```
  </style>
</head>
<body>
  <video hidden id="zoom">
    <source src="PROJECT_CAMERA_ON.mp4" type="video/mp4">
      Your browser does not support HTML5 video.
    </source>
  </video>
  <video id="camera" autoplay></video>
  <div id="intro">
    <h1>Welcome to the experiment!</h1>
    <p>Hello! My name is <i>Kiran Nicole Rai</i> and I am currently working on my final project as part of the
    <i>Human-Computer Interaction</i> MSc program at the <i>University of Birmingham</i>. This experiment is under
    the supervision of <i>Russell Beale</i>, a professor of Human-Computer Interaction at the university. This
    experiment is a component of my dissertation. Your data and responses will be recorded anonymously and used for
    research purposes only.</p>
    <p>For this experiment, you must use a laptop or PC. You MUST have your webcam on. Your video will not be
    recorded. You will be a guest in a meeting of four university students and you must pay attention throughout
    this experiment as you will be asked some questions at the end. The meeting will last for just under 10 minutes
    and, when the meeting has finished, you will be automatically redirected to a Google Forms page where you will
    be asked the questions. Once you begin the meeting, you will not be able to fast forward nor rewind it, but you
    may pause. Upon pausing the meeting, you will not be able to see anything until you press play again. You must
    NOT refresh the page at any time or you will have to restart the experiment. Do not worry if the meeting
    sometimes freezes for a few seconds - this is normal. </p>
    <p>If you have any questions, please feel free to text or email me at <a
    href="mailto:knr756@student.bham.ac.uk">knr756@student.bham.ac.uk</a>. Please press 'Begin Meeting' whenever you
    are ready to start the experiment. If you have paused, press 'Play' whenever you are ready to resume the
    experiment.</p>
    <button id="start" onclick="startMeeting()">Begin Meeting</button>
  </div>
  <script src="https://cdnjs.cloudflare.com/ajax/libs/jquery/3.6.0/jquery.min.js"></script>
  <script>
```

```
    const masterWidth = 1920;
    const masterHeight = 1080;
    const aspectRatio = masterWidth / masterHeight;

    var camera = $("#camera");
    var zoom = $("#zoom");
    var start = $("#start");
    var intro = $("#intro :not(#start)");
    var video = zoom.get(0);

    // --- starts the webcam - code block from https://davidwalsh.name/browser-camera

    if(navigator.mediaDevices && navigator.mediaDevices.getUserMedia) {
        navigator.mediaDevices.getUserMedia({ video: true }).then(function(stream) {
            camera.get(0).srcObject = stream;
            camera.get(0).play();
        });
    }

    // --- experiment code starts here

    function startMeeting() {
        if (video.paused) {
            video.play();
            intro.hide();
            zoom.show();
            start.html("Pause");
        } else {
            video.pause();
            intro.show();
            zoom.hide();
            start.html("Play");
        }
    }
```

```
function endMeeting() {
    zoom.hide();
    camera.hide();
    start.hide();
    alert('The meeting has ended and you will now be redirected to Google Forms to answer some post-meeting
    questions.');
    window.location.href = 'https://docs.google.com/forms/d/e/
1FAIpQLSeGlwome4F6dIyerk4nmii07Ho4HdkvXLMMIubND3oUtLbEWA/viewform?usp=sf_link';
}

function placeCamera() {
    let newRatio = zoom.width() / zoom.height();

    if (newRatio > aspectRatio) {  // bars are in width
        let videoHeight = Math.floor(zoom.height());
        let videoWidth = Math.floor (videoHeight * aspectRatio);
        let offset = (zoom.width() - videoWidth) / 2;

        camera.css("width", videoWidth / 3);
        camera.css("height", videoHeight / 2);

        camera.width(videoWidth / 3);
        camera.css({ top: videoHeight / 2, left: offset + videoWidth / 3 });
    } else {  // bars are in height

        let videoWidth = Math.floor(zoom.width());
        let videoHeight = Math.floor (videoWidth / aspectRatio);
        let offset = (zoom.height() - videoHeight) / 2;

        camera.css("width", videoWidth / 3);
        camera.css("height", videoHeight / 2);

        camera.height(videoHeight / 2);
        camera.css({ top: offset + videoHeight / 2, left: videoWidth / 3 });
    }
}
```

```
    video.addEventListener('ended', endMeeting);
    $(window).resize(placeCamera);
    placeCamera();

    </script>
</body>
</html>
```

Appendix F: HTML document for condition one.