Spring 4-19-2021

Animated Videos: The Covid-19 Pandemic

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Honors Project

Submitted to the Honors College at Bowling Green State University in partial fulfillment of the requirements for graduation with University Honors May 2021.

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This project is dedicated to my original Primary Advisor, Neocles Leontis, and my Uncle Bob who both tragically passed away during the completion of this project.

Project Overview

This project is a resource created to provide information about the Covid-19 pandemic. This pandemic was caused by the SARS-CoV-2 virus (AJMC Staff, 2021). The first reported cases began to appear in December 2019, and the World Health Organization (WHO) declared COVID-19 a pandemic on March 11th, 2020. This pandemic is still active with new cases reported everyday as of April 2021 (AJMC Staff, 2021). This resource consists of four videos ranging from around two and a half to eight minutes long. All videos were created in an animated fashion and were uploaded to YouTube. The first video focuses on the background and origin of the SARS-CoV-2 virus. The second video looks at how the virus is transmitted and ways to prevent the transmission. Information about how the virus replicates and the different proteins of the virus involved during infection is covered in the third video, and the fourth video talks about several different vaccines that are being used to help stop the COVID-19 pandemic. A detailed look at the contents of these videos can be viewed below where the transcriptions for each video have been written out.

Video 1: Covid-19 Background and Origin Script

Covid-19 has been a term we've heard quite often in today's world, but what exactly is Covid-19. It is the name for the illness caused by the virus SARS-CoV-2 (AJMC Staff, 2021). The first detected COVID-19 illness was in Wuhan, China back in late 2019 (AJMC Staff, 2021). It was believed to have originated in bats making it a zoonotic disease, because its viral vector was able to jump from another species to humans due to mutations (Haider et al., 2020). This event often happens in wet markets. Wet markets are places that sell fresh seafood and wild animals that are slaughtered upon purchasing. This

includes bats. Although fresh cut meat sounds nice, wet markets are often unsanitary and animals are crowded allowing zoonotic diseases to develop (Haider et al., 2020). Some may question the wet market theory and go on to say that the virus was engineered in a lab, but I'm here to tell you that it was not (Healy, 2020). This virus is all natural. If the SARS-CoV-2 virus was made in a lab, its genome would have been constructed using bits and pieces of already known viruses to make one super virus. This virus may have similarities to others, but there are some major differences and components of its genetic material that we have never seen before. This means the virus came from nature, and nature can often be harsh (Healy, 2020). This one case of SARS-CoV-2 spread rapidly to others causing an epidemic in the Chinese nation (AJMC Staff, 2021). This virus was spreading so quickly that this epidemic became a global pandemic leading to the death and illness of millions, but this isn't the first coronavirus we've seen have detrimental effects (AJMC Staff, 2021). Between 2002 and 2003 SARS, meaning Severe Acute Respiratory Syndrome, spread to more than two dozen countries and led to the illness of 8,098 and death of 774 (*SARS* 2005). This virus also originated in China (*SARS* 2005). A more recent outbreak occurred in 2012 due to MERS, or Middle East Respiratory Syndrome, first seen in Saudi Arabia *(MERS-CoV* 2020). This virus caused illness to 2,562 and the death of 881 *(MERS-CoV* 2020). The Covid-19 pandemic is one of the worst we've seen in modern history.

Video 2: Covid-19 Prevention and Transmission Script

In this video we will look at how the Sars-CoV-2 Virus is transmitted and what we can do to prevent that transmission. Sars-Cov-2 spreads through a mechanism known as

droplet transmission (Bourouiba, 2020). When a person breathes, talks, coughs, or sneezes, respiratory droplets are released into the air. If a person has COVID-19, there will be viral particles in these droplets which can travel through the air (Bourouiba, 2020). Studies done in the past have shown that up to 40,000 droplets, sized between 0.5-12 micrometers in diameter, can be produced in just a sneeze (Atkinson, et al., 2009). When it comes to coughing or talking for a period of just 5 minutes up to 3,000 droplets can be expelled from the mouth (Atkinson, et al., 2009). A more recent study done by the Massachusetts Institute of Technology found that when a person sneezed, these droplets traveled between 33 to 100 feet per second and made a cloud of droplets that spanned from 23 to 27 feet (Bourouiba, 2020)! Here is a picture of the particles coming from a sneeze taken during the study. Just think about how many COVID-19 particles are flying at you if you're with someone who has the virus! Evidence suggests that this is the main mode of transmission for the virus, but there is still a possibility that the virus could remain on surfaces (Bourouiba, 2020). This is why it is important to wash your hands for at least 20 seconds with soap and warm water before you touch your eyes, mouth, or nose, before you eat, after using the restroom, and whenever you come home (*Practice good hygiene* 2021)! Other good ways to prevent surface transmission is using hand sanitizer that contains at least 60% alcohol and cleaning commonly touched surfaces with a disinfectant often (*Show me the science* 2020). The CDC recommends using a third of a cup of bleach that contains 5 to 9 percent sodium hypochlorite per gallon of room temperature water (*Cleaning and sanitizing* 2021)! Going back to the virus's main mode of transportation: droplet transmission, let's look at how we could prevent those droplets from entering your body (*COVID-19 can wreck your body* 2020). Covid-19 can invade

the body through the nose, mouth, or eyes. The best ways to prevent this entry into the body is through social distancing, wearing a mask, and using eye protection. Social distancing is keeping space between you and other people. In the case of COVID-19 this space should be at least 6 feet apart (*Social distancing* 2020). Although MIT found that the droplets can reach as far as 27 feet, most of these droplets are smaller allowing them to stay in the air for longer periods of time. COVID-19 viral particles are usually found in larger droplets which fall to the ground quicker due to them being heavy (Atkinson, et al., 2009). Being 6 feet apart gives a large enough space between you and another individual, that droplet containing Covid-19 virus particles will most likely fall to the ground before reaching you (*Social distancing* 2020). Research has found that COVID-19 spreads mostly between people who are in close contact or are less than 6 feet apart. This evidence supports why we should practice social distancing (*Social distancing* 2020)! Another way to prevent COVID-19 is by wearing a mask (*Your guide to masks* 2021). These masks can be purchased at the store or be handmade! When choosing a mask there are several things to consider… make sure the mask has two or more layers and is made with a fabric that is washable and breathable. Also, make sure the mask covers your mouth and nose completely with no gaps on the sides. It is also helpful for the mask to have a nose wire so that air doesn't leak from the top of the mask (*Your guide to masks* 2021). There are many speculations around if masks actually work or not, but when you look at the science behind this preventative measure it makes sense (*Why is cotton* 2001). The most common fabric mask is made of cotton. When something is “scared of” or repels water, we call it hydrophobic. When something “likes” or attracts water we call it hydrophilic. Cotton is a hydrophilic substance and can hold up to 25 times its weight in

water. For the chemistry people out there, I'll explain how this works. Cotton comes from a substance known as cellulose. Cellulose is a sugar, or carbohydrate. On the outer edge of a cellulose molecule, you can see OH groups. These OH groups are slightly negative because oxygen is very good at attracting negative charges. When looking at water, or H2O, we can see that the oxygen pulls the negative charge away from the two hydrogens. This allows the hydrogens to be slightly positive. This difference in charges allows water and cellulose to stick to one another because opposites attract (*Why is cotton* 2001). This science is the reason behind why having a mask with more than one layer is more effective. The covid-19 viral particles are in respiratory droplets which are made of water. If these droplets pass through the mask, they will most likely get stuck in the first layer. Another reason mask are essential in reducing the spread of COVID-19 is because it acts as a barrier. Earlier we saw that a sneeze could propel respiratory droplets at 33 to 100 feet per second (Bourouiba, 2020). Let's look at this image taken by peers at the University of South New Whales in Australia, of a person sneezing, coughing, and talking (Macintyre, et al., 2020). We can see that when the person was not wearing a mask, respiratory droplets dispersed easily through the air. When they were wearing a single layered cloth mask, even though some particles may have gotten through, they were slowed down by the fabric, so the respiratory droplets didn't travel as far. This image also shows how important it is to have a mask that is two layers rather than one. Wearing a two layered fabric mask is also pretty similar to wearing a surgical mask. Many people are concerned with the viral particle making it through the pores of the mask, but we must remember that even though the virus is small, it is transported through a droplet of water which is much bigger (Macintyre, et al., 2020). Many fabric and

surgical masks do protect down to the size of a respiratory droplet, but no method of prevention is perfect. However, if we practice all the methods described in this video, we can get pretty close to a full-proof system of protection. Think of each method as a slice of swiss cheese (Scofield, 2020). Each slice has some holes in it, just like each method of prevention isn't perfect. Now let's stack them all on top of one another. By using more than one method to prevent the spread of COVID-19, we cover the holes that the virus might have crept through if we only used one (Scofield, 2020). Prevention is key to controlling this pandemic and we ALL have to come together, socially distanced of course, to stop the spread of COVID-19.

Video 3: Covid-19 Proteins Script

In this video we will discuss how Covid-19 works. The Covid-19 virus is a novel or new coronavirus. Corona viruses are known for their crown like appearance due to different membrane proteins surrounding its surface. The word corona actually means crown (Steinmetz, 2020). Three of these important surface proteins are the spike protein, the membrane protein, and the envelope protein (Seah, et al., 2020). When looking inside the cell you will find the nucleocapsid which is the viruses genetic material surrounded by a capsid, or protein coat. The genetic material for the coronavirus is made up of ribonucleic acid, or RNA. This RNA, as well as the other proteins, will be important when it comes to hijacking the human body (Seah, et al., 2020). Now let's go back and look at 3 important proteins found on the SARs-Cov-2 viruses' surface. The membrane, or M, protein is essential in assembling the parts of the coronavirus and also determines the shape of the viral envelope by interacting with the Envelope protein (Haan, et al., 1998).

The E protein creates an envelope around the genetic material of the virus that is made of a lipid bilayer (Haan, et al., 1998). A lipid bilayer is a membrane that has two layers of specific lipid molecules (Lenard, 2008) known as phospholipids, which have two major components (Lenard, 2008). A hydrophobic tail and a hydrophilic head (Alberts, 2002). Hydrophobic means that the component will repel water while hydrophilic components attract water. These hydrophobic and hydrophilic properties act like a guard by serving a huge role in protecting the nucleocapsid from being degraded (Alberts, 2002). Throughout this envelope we can find several different proteins embedded in it including the E proteins... the M proteins…. And the S or spike proteins. The S protein is essential for gaining access to human cells and has two domains: S1 and S2 (Huang, 2020). The S1 subunit contains the receptor binding domain. When a corona virus enters the body, it will find an ACE2 receptor on the surface of our cells and use this S1 subunit to bind with it (Huang, 2020). ACE2 receptors can be found throughout the body, but they are very abundant in the lungs and small intestines (Hamming, et al., 2004). This explains why some of the major symptoms of the virus are gastrointestinal and respiratory issues (Hamming, et al., 2004). Once the S1 subunit is bound to the ACE2 receptor, the S2 subunit will help pull the virus to the human cell membrane where fusion can occur, and the virus will enter the cell (Huang, 2020). Now that the virus has entered the cell, the nucleocapsid will be removed from the RNA and the RNA will enter the cytoplasm (*Sars-cov-2 and covid-19 pathogenesis* 2020). This RNA will then be translated using the host ribosome into viral polyproteins called pp1a and pp1ab. The next step will be proteolysis. Proteolysis means to break down proteins using enzymes into smaller amino acids. These pieces will then be used to create a replication-transcription complex. Using

this complex the RNA can be replicated into more genomic RNA and transcribed into four mRNA stands. Each mRNA stand will then be translated using the host ribosome into their designated protein. The structural proteins, E, S, and M will insert themselves into the membrane of the host endoplasmic reticulum, or ER, which surrounds the nucleus. The structural proteins will then be transferred to the Golgi apparatus through an endoplasmic-reticulum-Golgi intermediate compartment or ERGIC. The Golgi apparatus is responsible for packaging things into vesicles, or small bubbles. While this is all happening, the N proteins will find the replicated viral RNA and start to build a coat around it. At the Golgi apparatus a new virus will start to assemble and bud off of the Golgi. During this process the virus will also be combined with the nucleocapsid. Once a mature virion has been formed it will have a Golgi vesicle surrounding it. This bubble-like structure will carry the virus to the cell membrane and release the virus into the body through a process known as exocytosis (*Sars-cov-2 and covid-19 pathogenesis* 2020). This process will continue on producing disease, death, or until our immune system learns how to fight off the virus.

Video 4: Covid-19 Vaccines Script

Now that we've learned about the origin of COVID-19, how it's transmitted and ways to prevent that transmission, we'll move on to the newest breakthrough… the COVID-19 vaccines! Vaccines are usually shots and people receive them to trigger the immune system to build up strength against, or immunity to, certain viruses or pathogens (*Vaccine types* 2021). There are several different types of vaccines. The first type is a "Live-attenuated vaccine." This type of vaccine uses a weakened form of a live pathogen. Some

examples of this type of vaccine are the Measles, mumps, and rubella vaccine as well as the chickenpox vaccine. The next type of vaccine is an 'inactive vaccine." Vaccines for the Flu and Polio are examples of inactive vaccines. These vaccines are created using a killed version of the pathogen. A third type is called a subunit, recombinant, polysaccharide, and conjugate vaccine which uses a piece of the pathogen, like its sugar, capsid, or protein to create a vaccine. Diseases like shingles and pneumonia are prevented using these types of vaccines. The fourth type of vaccine is a toxoid vaccine. A common example is a tetanus shot. This type is unique because it is created using a toxin, or harmful byproduct, secreted by the pathogen. After being vaccinated, if a person were to contract the pathogen our immune system would target the toxins rather than the pathogen itself (*Vaccine types* 2021). The vaccines used for the COVID-19 virus are a bit different than these four traditional ones. As of December 2020, two vaccines have been approved for use to prevent the spread of COVID-19 in the United States (Corum & Zimmer, 2020a). The first vaccine approved came from a company known as Pfizer & bioNtech, next came one from Moderna, and another that is in the process of being approved is one from AstraZeneca. Now let's take a look at how these vaccines work. For all 3 of these vaccines a specific part of the corona virus's RNA genome is targeted. This target is the Spike protein gene which codes for the spike proteins found on the outside of the Coronavirus cell. Both the Pfizer and Moderna Vaccine work very similar to one another. They use a newer technology called an mRNA vaccine. mRNA stands for messenger Ribonucleic acid. RNA is single stranded genetic material. Both companies made their vaccine by extracting and replicating the segment of RNA that codes for the spike protein. After extracting this part of the Genome, the RNA will be surrounded by

oily bubbles known as lipid nanoparticles. This helps protect the fragile piece of RNA from being degraded by enzymes in the human body once it is administered. This particle is so fragile the vaccine must be stored at freezing temperatures. The Moderna vaccine is stored at -4 degrees Fahrenheit and the Pfizer vaccine is stored at -94 degrees Fahrenheit. After the vaccine is given, the RNA particle surrounded by the lipid nanoparticles will find a human cell in the body and fuse with its cell membrane. After fusing, the RNA will be released into the cell. Once the RNA is in the cell it is treated as mRNA. It holds the message to create the spike protein. This message can be read by a protein found in human cells called a ribosome. The mRNA is threaded through the ribosome and tRNA, or transfer RNA, brings amino acids to the ribosome that match the message. Once the entire mRNA is read by the ribosome, there will be an amino acid chain, or polypeptide, that folds into the spike protein. This process will continue until there are many spike proteins. 3 of the proteins will then combine to make one spike. The proteins might also be broken into fragments. The spikes or fragments created will then travel to the cell membrane to be presented on the surface. Once spikes or fragments are on the surface, the immune system can recognize them as foreign (Corum & Zimmer, 2020a). Now that we know how Pfizer and Moderna vaccines work, let's look at how a different vaccine, that might be coming to the United States in the future, works. The AstraZeneca vaccine is a DNA vaccine (Corum & Zimmer, 2020b). DNA, or Deoxyribonucleic acid, is the genetic material that humans have. This vaccine was created using a similar segment of RNA from the SAR-Cov-2s genome that the Moderna and Pfizer vaccines used, but the AstraZeneca team then converted this RNA segment to DNA. The difference between RNA and DNA is that DNA is double stranded and is made using a slightly different set

of nucleotides, or building blocks, than RNA. A perk to using DNA rather than RNA is that it is more stable, which allows for the vaccine to be stored at 72 degrees Fahrenheit instead of freezing temperatures. Once the synthetic piece of DNA is made, it is then inserted into an adenovirus. An adenovirus is typically the type of pathogen we see that causes a common cold. In the case of this vaccine, an altered version of a chimpanzee adenovirus was used. After the vaccine is administered, the adenovirus carrying the synthetic DNA will find a human cell and latch onto the surface. The human cell will then engulf the adenovirus into a bubble, or vesicle, and transport it into the cell. This process is called endocytosis. Inside the bubble the adenovirus prepares itself to leave the bubble. The adenovirus will then escape the bubble and find the nucleus of the cell. Once at the nucleus, the adenovirus will inject the synthetic DNA. Inside the nucleus the synthetic DNA can undergo a process known as transcription. Transcription is when the DNA is converted to mRNA. The mRNA will then leave the nucleus through a pore and undergo the same process the mRNA in the Moderna and Pfizer vaccine does (Corum & Zimmer, 2020b). It will travel to the ribosome and be translated into a polypeptide (Corum & Zimmer, 2020a). The polypeptide will then be folded into a spike protein, and lastly the proteins will be combined into spikes or broken into fragments which can be presented on the surface for our immune system to recognize (Corum & Zimmer, 2020a).

These videos are intended for individuals that are in college and are taking science classes. They can be viewed on the YouTube channel *Learning with Bailey.* These videos will hopefully be able to educate science majors in an interesting way about the pandemic rather than reading articles or doing research. It is essential for science majors to know about the pandemic

so they can educate and inform people around them. Those people can then tell more people about the virus and hopefully a ripple like effect can occur.

Overall Experience and Conclusions

Changes from Proposed Project:

The proposal for this project was created during the Summer 2020 semester. Since then, several things have changed. This project originally was going to target the younger population, particularly those in middle and high school. This age group was the initial target because they are the future. They are the ones who can really make a change as well as being old enough to start to make decisions and educate the older population. Another reason for targeting this population is due to the passion I have for working with individuals in the kid to teenage age groups. However, as the project developed over time, more and more information started to come out about Covid-19. A lot of this updated information was about the vaccines, transmission, and proteins of the virus. This material was very interesting to me but was definitely more complex. I ended up shifting my focus towards science majors in college. Many science classes in college don't have time to teach a whole unit on the Covid-19 pandemic as there is a lot of other material to cover. I found this to be a big reason to shift my focus towards college science majors. Many of them will be our next doctors and researchers. They need knowledge about the pandemic, so they can spread the information and educate more and more people. This resource summarizes different aspects of the virus in a concise way that students in a college science class should hopefully be able to understand. By uploading the videos to YouTube, it gives them a way to access the information. The other thing that has changed is that initially I was going to do videos where I drew on a whiteboard and then did a voice over.

Professionals who do these types of videos make it look easy, but it's actually a lot harder than it looks! I decided to use the computer program VideoScribe to create the videos, because it made my project more manageable and allowed the videos to have a similar look to what I was initially going for!

Methods:

For the completion of this project, I used several different applications and programs on my laptop. However, before using any of these programs, I did research and wrote a script for each video. After the completion of the script, I moved on to the main program used for this project called VideoScribe (Impressive animated videos). This program allowed me to create the animated, or video, portion of this project. Essentially, in this program I would use already uploaded figures and characters on the software and create the visual part of the story by matching them with the script. The next step was to record the audio portion using the Voice Memos application (Apple). Here, I recorded around one-minute segments of the script. I then pieced those segments together in the GarageBand program (GarageBand for Mac). After the audio and visuals were complete, it was time to merge them together. This took place by uploading the audio to the VideoScribe, and then adjusting the timing of the visuals to the audio. This was definitely the most time consuming and tedious part of the project. Each of the four videos created were the result of several different files from VideoScribe pieced together. For example, *Video One: Covid-19 Origin and Background* had four different smaller videos pieced together to create the final product. This step was completed using a program called iMovie (Imovie). The final step was to upload these videos to a YouTube account I made specifically for

this project, which will act as a vault for all the videos. This YouTube account is called *Learning with Bailey* (https://www.youtube.com/channel/UCWLD5Z7KbB4sNwNhPH6I1cQ/featured).

Struggles and Motivations:

While constructing my honors project I ran into many struggles I never thought would have happened. The idea for this project sparked when I was taking an online Biochemistry class with Professor Neocles Leontis. Usually, this class would be in person, but due to taking this class during a global pandemic it had to be online. Regardless of it being online, I looked forward to coming to this class every week. Leontis may have been one of the most intelligent people I knew, but he had a passion for sharing his knowledge with others. If you were confused or didn't understand he never got mad. He would have office hours and talk with you about the content until you could understand. He also knew how to make learning fun and applicable to the real world. In almost every section we covered, there was a way he related it to the Covid-19 pandemic. He wanted everyone to have information about the latest updates and what they could do to stay safe from the virus. Leontis loved doing what was best for others, and his passion for spreading awareness about the pandemic is what brought me to asking him to be my primary advisor and is what helped me develop the idea for my project. I am very fortunate and grateful to have gotten to work with a person like Leontis. However, it is very unfortunate and sad that he was never able to see the completion of this project as he passed away shortly before the end of the Fall 2020 semester. This death was a very hard pill to swallow. I had just had a meeting with him the day before. On top of the death of Leontis, I had also learned on the same day that my uncle who had been in the hospital battling Covid-19 passed away. That day I really felt as if my world had been flipped upside down. For about a month after it was hard to even open up my

laptop to work on the project let alone think about it. Over time, I turned these struggles into motivations. I wanted to spread awareness about the virus and educate others just like Leontis did, and I wanted to use that education to honor my uncle as well as everyone else who died, or knew someone who died, from the Covid-19 virus. This project may have had many bumps along the way and took longer than intended, but I am very happy with how the final product turned out. I would especially like to thank Lisa Handyside, Juan Bouzat, and Christine Shaal for supporting me with this project and the struggles experienced along the way.

Learning Experiences:

Throughout this project I had several learning experiences. The first one was time management. Because I completed my project during a global pandemic everything was online including all of my other classes! This was definitely a challenge to adjust to, because it was a lot harder to stay on track, focus, and be organized when you are confined to your bedroom with a 13-inch screen to stare at all day. As the project moved along, I got better and better at learning how to properly manage my time. Another thing I learned a lot about is technology. Before starting this project, I definitely was not the best at using computers. However, because everything was online, and I used several different applications and programs to complete my project I really learned a lot of useful computer skills relating to audio, animation, converting files, searching the web, and other things that I can hopefully use in the future. The third major thing I learned about is kind of obvious, but it is the Covid-19 pandemic. Throughout this project I was able to stay up to date on all the new information about the virus and find reliable sources, giving me the ability to share my knowledge with others. I know I will continue to use this knowledge to educate others about the ongoing pandemic and to tell future generations about

what it was like to experience a virus taking over the world. Finally, I learned to be proud of myself. Throughout my life I have always been a hardworking and determined student, but often doubted myself. I doubted myself several times throughout the completion of this project, but now that it is complete, I am very proud of how it turned out. I really surprised myself with what I could accomplish with this project

Hopes for the Future:

Now that my project is complete, I have several hopes for the future. My first hope is that this project can be used as a resource in college science classrooms to educate those who have a passion for science about the virus. These individuals should be able to understand the complexity of some of the material presented in these videos. If we educate more science majors about the pandemic, they will be able to share reliable information with others. These other people can then reach out to more people and the trend can continue. I also hope that the average adult can use these videos as a tool to educate themselves if they want to know more detailed information about the Covid-19 pandemic. Some information might be complex, but by watching it over a couple of times hopefully they will be able to understand the main points! If I continue to make more videos, I would like to make mini videos for each of the longer ones that summarize the main points in a simple and concise way. Lastly, I hope that these videos can serve as a time capsule for future generations to take a look back at what was going on during today's world.

Important Links

Link to YouTube Channel (Learning with Bailey)

https://www.youtube.com/channel/UCWLD5Z7KbB4sNwNhPH6I1cQ/featured

Link to Video 1: Covid-19 Background and Origin

https://youtu.be/ohfZiSiJaQY

Link to Video 2: Covid-19 Prevention and Transmission Script

https://youtu.be/FdTEwug8bHw

Link to Video 3: Covid-19 Proteins

https://youtu.be/LfbqLWcSl9E

Link to Video 4: Covid-19 Vaccines

https://youtu.be/jg8eiPQmgwg

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