SGI-JOURNAL OF SOCIAL SCIENCE AND HUMANITIES
VOLUME. 7
ISSUE. 1
MARCH, 2026

SACRIFICES ON THE ALTAR OF SCIENCE: THE CASE OF MODEL ORGANISMS

[1]Virginia J. Grigoriadou
[1]Department of Humanities Social Sciences and Law, National Technical University of Athens, Greece.

Abstract
This research traces and examines specific examples of the application of model organisms during the experimentation of biomedical sciences and psychology. The main purpose of the study is to compare how scientists utilize animal models for experiments with specific cases of humans who were used as test subjects, focusing on methodologies and main motivations. A core question that motivated this work is: Can we use the term "model organisms" to refer to human beings? In other words, can human beings be considered analogue models, specifically model organisms? This study will try to respond to the above question, by drawing upon theoretical frameworks and definitions from the field of philosophy of science, particularly focusing on the concepts of the analogue model, model organisms, and animal model. It will also analyze specific examples of experimental utilization of animal models, such as Hippocratic physicians' experiments involving goat brains, Galen's experiments on a pig during the Greco-Roman period, and the utilization of guinea pigs in modern scientific research. Finally, the study will examine historical examples where humans were used as test subjects including the Nazi medical experiments during World War II and the Stanford prison experiment conducted by psychology professor Philip G. Zimbardo.
Keywords: Model Organisms, Hippocratic Doctors, Galen, Guinea Pigs, Nazi Medical Experiments, Stanford Prison Experiment.

I. Introduction

Although the roots of the experimental utilization of scientific model organisms can be traced back to antiquity, their systematical application is placed in modern times through the experimentation of biomedical sciences. The application of model organisms supports scientific research. It contributes to the development of new treatments, and the discovery of medicines capable of facing the symptoms of serious diseases or even saving human lives. However, this practice leads to organisms' instrumentalization and triggers several inquiries regarding how ethical this practice is as it results in the unwilling pain and death of living organisms. Several philosophers and scientists agree that if we must choose between the life of a hundred guinea pigs and the discovery of a treatment or a medicine capable of saving the lives of millions of human beings, we must choose the second one as the "more ethical choice".

According to the widely accepted definition of model organisms, these models are "non-human species extensively studied to understand a range of biological phenomena" (Fields & Johnston, 1986; Ankeny, 2021). But what if the model organism was not an animal but a human being? What would be the "right" decision in this hypothetical case? Is this case hypothetical? Moreover, can human beings, in specific cases, be considered scientific models? These questions may seem exaggerated or unrealistic at first, but history provides us with several examples of using humans as test subjects; several people were sacrificed on the altar of science literally or metaphorically, without being asked and without agreeing or consciously agreeing.

This study will try to answer the above questions, drawing from theoretical approaches and definitions of the concept of the analogue model and its subcategory model organism that comes from the field of philosophy of science and specific examples of animal and human experimental utilization from the history of science. This study aims to compare the reasons that lead to the utilization of animal models and human being models, as well as

how they are utilized during medical experiments. To address these points, we will examine specific cases of animal models' application but also examples of "human being models." Then we will compare the function of these "tools," how they were applied, and the purpose of their utilization through the scientific activity to conclude if we can perceive humans as scientific models.

Analogue Models: The Case of Animal Models

Since the 18th century, scientific models have been a widespread and steadily developing experimental technique, the utilization of which is constantly expanding into new scientific fields. Scientific models are powerful tools of modern science widely used in various scientific fields to contribute to concluding, explaining relationships, controlling, and predicting the phenomena under consideration (Rogers, 2012; Frigg and Hartmann, 2020). From the first decades of the 20th century, philosophers and scientists have engaged in an ongoing dialogue concerning the perception and theoretical documentation of the concept of the scientific model (e.g., Norman Cambell, Marry Hesse, Margaret Morrison, Roman Frigg, Stefan Hartmann, Axel Gelfert, etc.) (Grigoriadou, 2022). In the modern philosophy of science, the concept of a scientific model is often attributed either as the representation of a physical object, phenomenon, or system or as the interpretation of theories (Rogers, 2012; Frigg and Hartmann, 2020) while in the past it was also attributed as structural isomorphism, as an equivalence of structural relations (Christodoulidis, 1979; Grigoriadou, 2023). Scientific models connect human thought to reality either as the representation of a physical object, phenomenon, or system, or as the interpretation of theories, which gives meaning to the axioms, theorems, rules, or propositions of the theory (Rogers, 2012; Frigg and Hartmann, 2020; Grigoriadou, 2022).

Analogue, material, or physical models are a scientific models' wide subcategory. These models are physical objects, systems, organisms, and scenes, constructed or chosen based on a specific similarity to a system under study, the target system, and they are used to describe, explain, or contribute to making predictions about this system (Grigoriadou, 2022). Animal models fall into the category of analogue models (Sterrett, 2005). Animal models are specific species reproduced in laboratories and utilized during experimentation of several scientific fields with dominant biomedical sciences; their application is based on identifying and verifying specific similarities between them and the target system, which is usually the human organism. These similarities are often related to the function of specific physiological processes of their organisms, similar illnesses, and the similar reaction of their organism to a medicine or an experimental treatment.

A core question is why analogue models, specifically animal models, have been chosen and how their wide application in scientific practice can be justified. Various reasons can explain the utilization of analogue models. Analogue models are applied to examine a system, a phenomenon, or an object that cannot be directly observed by researchers due to various limitations such as their size, space or time distance, or other reasons, even ethical (Grigoriadou, 2022). An analogue model is a concrete part of the real world, a physical object, system, phenomenon, situation, or more generally a physical set-up that represents another difficult-to-access selected part of the real world, the target system based on a specific and verified similarity between the two systems which is often expressed by an equation (Sterrett, 2017). Therefore, even if the researcher does not have access to reality per se, analogue models enable him to approach reality, understand, describe, and make predictions about specific parts of the real world (Grigoriadou et al., 2021).

In the case of model organisms, except that they are simpler organisms exploited to enhance our knowledge of more complex organisms, another core reason that leads to their utilization is related to ethics. Here the best-known example comes from the fields of medicine, pharmacology, and biology and is related to the systematic use of animal models for clinical trials. When scientists must examine, for instance, the effect of a drug or vaccine on the human organism, they design their experiment and choose the appropriate model to

test the treatment; they often use animal models, which are an extensive subcategory of analogue models, after verifying a certain analogy with the human organism in terms of a certain physiological function. Since experiments on humans go against the ethical rules, in modern science animals are systematically bred, reproduced, and used during experimentation. Some examples are guinea pigs, monkeys, and other animals whose anatomy, physiology, or some organic functions show significant similarities with their human counterparts. Hence, it could be argued that experimentation on animal models is deemed "ethically preferable" to experimentation on humans, particularly when considering the potential risks and implications for human health and well-being. Undoubtedly, this fact gives rise to fresh concerns and sparks ongoing philosophical debates concerning the ethics surrounding the use of experimental animals. Such discussions often revolve around the ethical considerations regarding the infliction of pain, permanent harm, and the eventual euthanasia of these model organisms.

Animal Models

The Roots of Animal Model's Experimental Application

The foundations of systematic medical science trace back to the school of Hippocrates during the 5th century BC and to a large list of writings in the Hippocratic Collection (Corpus Hippocraticum), based on experiment, observation, and logic. The roots of the conscious utilization of model organisms, specifically animal models characterized by specific similarities with human physiology can also be traced back to the school of Hippocrates. Animal models were used during the experiments of Hippocratic doctors to contribute to understanding, describing, explaining, predicting, and treating specific diseases (Grigoriadou, 2023). An interesting example is the utilization of dead goat heads to understand and describe the sacred disease (Andrew, 2007; Grigoriadou 2023). Until that time, epileptic seizures were attributed to divine intervention. However, the Hippocratic physicians, as they did not accept any other cause of disease than a natural cause, conducted experiments with animal models that exhibited analogous symptoms. Having noticed that goats have a similar disease to epilepsy, characterized by similar symptoms, they conducted anatomical examinations and studies of goat brains. Their observations revealed differences in texture and odor between the brains of diseased goats and those of healthy counterparts. Specifically, the brains of diseased goats exhibited a wet and malodorous characteristic (Lloyd, 2003; Andrew, 2007; Grigoriadou, 2023). According to the Hippocratic doctors, if such phenomena were evident in goats, it logically followed that similar pathological processes might underlie human epilepsy, positing fluid accumulation around the brain as a potential cause (Lloyd, 2003). In this context, the goat brain served as a model used to contribute to studying epilepsy in humans, given the symptomatic similarities between epileptic seizures observed in both goats and humans (Grigoriadou 2023).

Another historical example of animal models' experimental application comes from the Greco-Roman period. During this period, the application of animal models was developed and expanded by the famous doctor, Galen, who systematically dealt with the anatomy and physiology of the human body (Grigoriadou 2023). Galen used various animals, as analogue models, in his experiments, such as pigs, goats, monkeys, and elephants. Notably, he conducted investigations on a pig aimed at elucidating the neural control mechanisms originating from the spinal cord. Through a methodical process of sequential spinal cord dissections in the test subject, Galen meticulously observed and documented the progressive cessation of specific physiological functions, thereby yielding valuable insights into the intricate workings of the nervous system (Grigoriadou 2023).

The Case of Guinea Pigs

Nowadays, a significant number of animal models are used in scientific experimentation of biology, pharmacology, and medicine. The most typical example is the guinea pigs, first used in 1882 by the German scientist Robert Koch, to discover that Tuberculosis (TB) was caused by the bacterium Mycobacterium tuberculosis. Guinea pigs

have biological similarities to humans, which make them useful in many fields of research and justify their extended utilization in scientific practice (Cambridge University, n.d.). The guinea pig's susceptibility to various infections, along with the similarities between its immune defense mechanisms and those of humans, has rendered it a crucial model organism in the investigation of infectious diseases. Moreover, guinea pigs are extensively used to provide tissues and organs for research.

Components of guinea pig blood are widely employed, and isolated organ preparations such as guinea pig lung and intestine serve as invaluable tools in pharmaceutical research, aimed at developing new medications. Notably, these tissue and organ preparations played a significant role in the discovery and initial development of beta blockers for hypertension treatment and drugs for managing stomach ulcers. Moreover, Guinea pigs have been extensively utilized in various studies aimed at enhancing our comprehension of acquired hearing loss induced by noise exposure and ototoxic drugs. Unlike rats or mice, guinea pigs exhibit hearing characteristics that are more akin to humans, despite their optimal hearing being at slightly higher frequencies than that of humans. This similarity makes guinea pigs a valuable model for investigating hearing-related conditions and developing potential interventions (Naert et al., 2019). Thus, guinea pigs are employed in research concerning allergies and respiratory diseases, nutrition research, hearing and safety testing and their application was important for the development of vaccines for diphtheria, TB, replacement heart valves, blood transfusion, kidney dialysis, antibiotics, anticoagulants, and asthma medicines (Cambridge University, n.d.).

Currently, guinea pigs play a crucial role in the quest for vaccines against viral diseases such as Ebola, Lassa Fever, various influenza viruses, and Coronaviruses. Their use aims to identify vaccine candidates that demonstrate promise in preclinical trials and can subsequently progress to human clinical trials through collaboration with pharmaceutical companies. Utilizing guinea pigs as animal models, researchers can evaluate the efficacy of potential vaccines in protecting against these diseases. This step is essential for establishing the safety and effectiveness of vaccines before they are tested in human subjects (Cambridge University, n.d.).

Although in all these cases the experimental utilization of animal models is considered crucial for the development of specific medicines, treatments, and vaccines, and on this basis for the development of science, it entails the instrumentalization of living organisms that pain, suffer, and finally they are led to death. Thus, the utilization of animal models can be perceived as a sacrifice on the altar of science. At the same time, some difficult-to-respond questions remain, such as: How ethical is it to use animals as test subjects? Is this the "preferable ethical choice"? Why don't we test the experimental treatments on ourselves? Why don't we take this risk? These questions may sound excessive, unrealistic, or hypothetical. But, approaching some cases where humans were used as test subjects, we can further reflect on this issue, discuss it, and identify similarities, and differences between the use of humans and the use of animals as scientific analogue models. On this basis, we will realize that the above questions cannot receive a clear answer and understand why they are a kind of apple of discord not only among scientists but also among moral philosophers.

Human Beings as Model Organisms

Medical Experiments of Nazis

The most notorious historical example of experiments that go against accepted moral values is the Nazi medical experiments mainly aiming at the "cleanse German society" (Holocaust Encyclopedia, n.d.). The Nazis during World War II used prisoners to test treatments for infectious diseases, to treat injuries, and to test exposure to various chemicals and poisons, leading more than 15,754 documented victims to death (Weindling et al., 2016). In the concentration camps of Dachau, Nazis carried out experiments to improve soldiers living conditions and increase their chances of survival on the battlefields. For example,

German scientists carried out freezing experiments on prisoners to find an effective treatment for hypothermia (Berger, 1990).

A second category of Nazi experiments conducted in the concentration camps of Sachsenhausen, Dachau, Natzweiler, Buchenwald, and Neuengamme, aimed to test drugs and treatments for injuries and infectious diseases that were faced by the German military such as malaria, typhus, tuberculosis, typhoid fever, yellow fever, and infectious hepatitis (Metzger et al., 2019; Holocaust Encyclopedia, n.d.). Between February 1942 and April 1945, around 1.200 prisoners at Dachau camp were subjected to malaria experiments. Healthy people were exposed to malaria-carrying mosquitoes. After contracting the disease, they were treated with synthetic drugs, administered at varying doses, some of which were fatal. Most of them died, while others survived with disabilities (Hulverscheidt, 2006).

Except for facing practical problems, the Nazis also used prisoners as test subjects to serve ideological goals. The most known case here is the series of experiments conducted by Josef Mengele, an SS doctor at Auschwitz. He carried out a series of experiments on Jews, Roma children, disabled people, and twins facing them as "ideal laboratory animals" (Jewish Virtual Library, 2008). Mengele exposed twins to freezing temperatures and low-pressure chambers. He was taking pictures of twins and keeping their teeth in plaster molds. Moreover, their prints were taken from hands and feet. Experiments involving sterilization through iodine, X-rays, or silver nitrate, as well as procedures like castration and artificial insemination that aimed at propagating the Aryan race, were conducted. Other widespread practices included euthanasia, genetic manipulation, racial examinations, and cruel procedures such as injecting chemicals into eyes to alter their color or creating artificial "Siamese twins." When the experiments were completed, some prisoners were killed by phenol injection. Their organs were analyzed, and specific specimens were shipped out to the institute in Berlin-Dahlem for further research (Jewish Virtual Library, 2008). In other cases, prisoners often undergo organ removal without any form of anesthesia. After 1945, body parts, particularly those obtained from euthanasia killings, were frequently preserved for research and educational purposes (Weindling et al., 2016).

The experiments were carried out without anesthesia and clearly without the consent of the prisoners for their participation. When the experiments were completed, the participants were led to death. Numerous prisoners perished during the procedures, while others were deliberately killed afterward to assess the internal effects of the experiments. A small number of survivors endured mutilation or other forms of incapacitation (Hulverscheidt, 2006; Weindling et al., 2016).

Undoubtedly, the Nazis used the prisoners as laboratory animals, as model organisms. Recalling the definition of analogue models and the basic reasons that lead scientists to use them we conclude that in the case of the medical experiments of nazis, human beings were faced the same way that Galen conducted experiments on the pig or on how contemporary scientists carried out experiments on guinea pigs as they are organisms that are chosen based on a specific similarity to a system under study and used to describe, explain, or contribute to making predictions about the target systems. Their application was based on specific similarities between them and the target system, which was the Aryan race in this case. These similarities are often related to the function of specific physiological processes of their organisms, similar illnesses, and the similar reaction of their organism to a medicine or an experimental treatment.

Moreover, in all these cases the test subject participated in the experiment without its consent. Thus, these practices undoubtedly lead to organisms' instrumentalization and are almost always accompanied by pain, permanent damage, and death. The only difference that can be identified is that, nowadays, scientists are following specific protocols aiming to limit the number of laboratory animals and the pain they provoke in them using specific drugs and techniques contrary to nazis' experiments where their dominant racist ideas, and their wish to "cleansing German society" stripped them every trace of sensibility towards the human being models.

Stanford Prison Experiment

Stanford prison experiment is a social experiment, a hypothetical prison simulation study that was carried out in August 1971, at the psychology building of Stanford University, by psychology professor Philip G. Zimbardo and his research team (Bartels 2019; Britannica, 2024; Stanford (a), n.d.). The experiment aimed to investigate the psychological impacts of authority and powerlessness within a simulated prison scene.

Professor Zimbardo invited students via a local newspaper advertisement to participate in a study concerning the psychological effects of prison life (Zimbardo et al., 2000). Twenty-four carefully selected male students, physically and mentally healthy were randomly assigned to represent prisoners or guards in a simulated prison environment. We must mention that they did not know each other before the experiment and were paid for their participation ($15 a day) (Zimbardo et al., 2000; Britannica, 2024).

The research team created a simulation, an analogue model of a prison. This simulated prison scene included a desolate corridor devoid of natural light or windows. The office entrances were fortified with iron bars, while closets had been repurposed into dim, isolated confinement spaces. The "yard" consisted of a 30-foot-long hallway in front of three makeshift prison cells, converted from former small staff offices (Zimbardo et al., 2000). Adjacent to this setup, three offices were allocated for the staff: one for changing uniforms, one for the warden, and another for the superintendent. Adequate space was allocated in the hallway for visitors on designated nights. Access and exit were limited to a single door, with the opposite end of the corridor sealed off by a wall constructed for this purpose. A discreet opening in the wall facilitated video surveillance and inconspicuous observation. Microphones were installed in the cells to clandestinely monitor prisoner conversations (Zimbardo et al., 2000).

Moreover, the representation of the scene of the prisoner's arrest and later the prison conditions were accurate. Prisoners were arrested and led to the simulation of the police station. The guards took pictures and fingerprints of them, and finally after removing their personal belongings and forcing them to wear white dresses; they were led to their cells. Prisoners did not have names but prison numbers (Zimbardo et al., 2000; Mcleod, 2023; Britannica, 2024).

Guards also were wearing identical uniforms and sunglasses. They were working eight hours each and their responsibility was to uphold law and order within the prison and earn the respect of the prisoners. They were explicitly prohibited from resorting to physical violence. Professor Zimbardo except for observing the behavior of the prisoners and guards played the role of prison superintendent (Zimbardo et al., 2000; Mcleod, 2023; Britannica, 2024).

Although the scene, the roles, the rules, and the costumes were precisely designed, neither group was given any instructions on how to behave (Zimbardo et al., 2000). From the first day of the experiment, the behavior of some guards became dangerous as they started to harass prisoners while the prisoners began to obey the rules of the prison. Although the experiment was planned to run for 1-2 weeks, it had to be terminated on the 6th day due to the dangerous behaviors of men of both groups (Stanford (a), n.d.; Mcleod, 2023; Britannica, 2024). The men assigned as guards began behaving sadistically, inflicting humiliation on the prisoners. Prisoners became blindly obedient, allowed themselves to be dehumanized and later they became depressed and hopeless (Stanford (b), n.d.; Zimbardo et. al, 2000). Dr. Zimbardo summarized the findings by illustrating how "ordinary college students" could commit atrocities under the influence of their roles (Stanford (a), n.d.; Mcleod, 2023; Britannica, 2024).

The Stanford experiment is an interesting and complicated enough example of the use of human beings as analogue models. At this point, we must mention that the whole experiment can be considered an analogue model representing a hypothetical situation. So, we can discern three levels of representation here and correspondingly three different kinds

of analogue models. The first analogue model represents the setting of the prison and the uniforms. The second analogue model represents the rules and the conditions; in this case, we have the simulation of a situation. The third and most important analogue model that can be identified is the model of the roles of the guards and the prisoners or more generally the model of organisms. Since in this paper, we are focusing on cases in which humans were used as model organisms during scientific experiments and we are examining if and to what extent they were sacrificed on the altar of science, we will focus on the latter case, "the representation of roles through model human beings."

But can the participants of the Stanford experiment be characterized as model organisms? The mock guards and mock prisoners were organisms, chosen based on specific criteria and specific similarities, such as human nature and behavior in similar environments and situations to a system under study which could be the conditions of a hypothetical prison. Moreover, the guards and prisoners were used to simulate reactions or behaviors to contribute to the description, explanation, or predictions about the target systems, that is the hypothetical similar scenes or situations. Thus, the participants of the Stanford experiment can be perceived as analogue models and specifically model organisms.

However, in this case, there is a core difference between the medical experiments of the nazis and experiments on animal models. The participants of the Stanford prison experiment chose to participate in the experiment as they responded to an invitation via a local newspaper advertisement. They also were informed about the experiment, the conditions, and the rules before the start of the research and they were paid for their participation. They had completed informed-consent forms indicating that some of their basic civil rights would have to be violated if they were selected for the prisoner role and that only minimally adequate diet and health care would be provided (Zimbardo et al., 2000). Thus, they had consent for their participation in the experiment. However, even though they had consciously decided to take part in the experiment, no one, not even the researchers themselves, could predict the outcome of the experiment, the extreme behaviors of the participants who were given power (we could call them "authority models") and the tendency to submit and the depressed feelings of the imprisoned (we could call them "submissive models").

Except for the impressive results and the conscious participation of the students, the case of the Stanford prison experiment still triggers inquiries and dialogues concerning how ethical is to lead human beings to live conditions capable of degrading the quality of human nature.

II. Conclusion

From the preceding discussion, it is evident that human beings have been employed under similar frameworks as analogue models, particularly as model organisms, whether with their explicit consent or without it. Indeed, human beings have been subjected to scientific experimentation in a manner and under conditions analogous to those applied to animal models. In the context of the Nazi medical experiments during World War II, it could be argued that the treatment of prisoners resembled more closely the experiments conducted by Galen on the live pig rather than modern guinea pig experiments, as anesthesia was not administered. There was a notable lack of regard for the well-being of the test subjects, with no efforts made to mitigate pain or suffering. This disregard likely stemmed from prevalent racist ideologies, viewing the experimental subjects, as inferior to the Aryan race and thus expendable. However, an important difference, particularly in contrast to the Hippocratic doctors or Galen, is that these ancient scientists did not harbor animosity towards the animal models they employed in their experiments.

Moreover, in the case of the Stanford prison experiment, the participants assumed roles akin to role models, particularly models of behavior. Therefore, the term "model organisms" could be aptly applied to describe these participants. However, a key disparity lies in the aspect of consent, and voluntary participation by the test subjects. Indeed, this

factor represents a significant departure compared to the earlier cases discussed. Nonetheless, fundamental issues remain such as the instrumentalization of living organisms, specifically individuals involved in a process that can diminish the essence of human dignity.

Examining the motivations behind scientists' selection of specific models in all instances, we find a commonality rooted in the significance of utilizing scientific models for experimentation. Their application is essential for investigating systems, phenomena, or objects that are not directly observable to researchers or difficult to access due to various constraints such as complexity, scale, spatial or temporal distances, or ethical considerations. Thus, scientists choose an analogue model, a model organism in our case, as a representation of another more complex (in some cases) and often inaccessible aspect of reality known as the target system. This representation is achieved based on a specific and confirmed similarity between the two systems. In cases of animal models and the victims of the Nazis, the selection of specific models of organisms for experimental utilization can be attributed to doctors' perceptions of human superiority over animals in the former case and the superiority of members of the Aryan race over prisoners in the latter. These perceptions influenced their judgment, deeming the chosen models as morally preferable options for experimentation. In the case of the Stanford prison experiment, the researchers chose to construct or select and use analogue models, such as the simulation of a prison environment and the guards and prisoners, to represent other more complex and inaccessible systems and circumstances such as a real prison. Therefore, the utilization of analogue models here was a solution capable of facing the possible difficulties of experimenting in a real prison.

The discussion concerning the utilization of model organisms is a kind of apple of discord for the contemporary scientific and philosophical community, as this scientific practice involves the instrumentalization of living organisms, often resulting in pain and suffering, and, in some cases leading them to mortality. However, in recent decades, universities and research centers established ethics committees or deontology committees to oversee and guide ethical practices within their institutions; these committees are responsible for supervising, and guiding ethical conduct within their respective institutions, including reviewing research protocols, ensuring adherence to ethical guidelines and regulations, and offering guidance on ethical quandaries arising in research endeavors. Moreover, these committees have increasingly emphasized ethical considerations in tackling this issue. Their efforts are directed toward reducing reliance on animal models, enhancing animal welfare during experimentation, and exploring the use of pharmaceutical interventions to alleviate animal suffering.

References

Ankeny, R.A. & Leonelli S. (2021). Model Organisms. Cambridge University Press.

Anrdew, G. (2007). Eureka. The birth of science. Translation in Greek by Mavroudi D.A. Thessaloniki: University Studio Press.

Bartels J. (2019). Revisiting the Stanford prison experiment, again: Examining demand characteristics in the guard orientation. The Journal of social psychology, 159(6), 780–790. https://doi.org/10.1080/00224545.2019.1596058

Berger, R.L. (1990). Nazi Science – the Dachau Hypothermia Experiments. New England Journal of Medicine, 322(20), 1435 -1440. https://doi.org/10.1056/NEJM199005173222006

Britannica, The Editors of Encyclopaedia (2024). "Stanford Prison Experiment". Encyclopedia Britannica, 19 Apr. 2024. Retrieved from https://www.britannica.com/event/Stanford-Prison- Experiment.

Cambridge University. (n.d.). Retrieved from https://www.cam.ac.uk/research/research-at-cambridge/animal-research/what-types-of-animal-do-we-use/guinea-pigs.

Christodoulidis, P. (1979). The explanation in science and the concept of model.

Thessaloniki: Egnatia publications.

Fields, S., & Johnston, M. (2005). Cell biology. Whither model organism research?. Science (New York, N.Y.), 307(5717), 1885–1886. https://doi.org/10.1126/science.1108872

Frigg, R. & Hartmann St. (2020). Models in science. In Ed. N. Zalta, (ed.), The Stanford Encyclopedia of Philosophy.

Grigoriadou, V., Coutelieris, F. & Theologou, K. (2021). History of the concept of similarity in natural sciences. Conatus-Journal of Philosophy, 6(1), 101-123. https://doi.org/10.12681/cjp.22955

Grigoriadou, V.J. (2022). Issues of similarity between scientific models and reality in the epistemology of Susan G. Sterrett (Doctoral dissertation). Retrieved from https://freader.ekt.gr/eadd/index.php?doc=52252&lang=el#p=2

Grigoriadou, V.J. (2023). The precursors of scientific models in ancient Egypt, Mesopotamia, and ancient Greek world: a comparative study. European Journal of Theoretical and Applied Sciences, 1(4), 574-582. https://doi.org/10.59324/ejtas.2023.1(4).52

Holocaust Encyclopedia. (n.d.) Retrieved from https://encyclopedia.ushmm.org/content/en/article/nazi-medical-experiments

Hulverscheidt, M. (2006). German Malariology Experiments with Humans, Supported by the DFG Until 1945. Man, Medicine, and the State: The Human Body as an Object of Government Sponsored Medical Research in the 20th Century, Beiträge zur Geschichte der Deutschen Forschungsgemeinschaft Volume 2. Ed. Wolfgang Uwe Eckhart. Stuttgart: Franz Steiner Verlag, pp. 221–236.

Jewish Virtual Library. (2008). Nazi medical experiments: Background & Overview. Encyclopaedia Judaica. Retrieved from https://www.jewishvirtuallibrary.org/background-and-overview-of-nazi-medical-experiments

Lloyd, G.E.R. (2003). Early Greek science. Translation in Greek by Karletsa P. Heraklion: Crete University Publications.

Mcleod, S. (2023) Stand ford Prison Experiment: Zimbardo's Famous Study. Simply Psychology. Retrieved from https://www.simplypsychology.org/zimbardo.html

Metzger, W. G., Ehni, H.-J., Kremsner, P. G., & Mordmüller, B. G. (December 2019). Experimental infections in humans – historical and ethical reflections. Tropical Medicine & International Health, 24(12), 1384 -1390. https://doi.org/10.1111/tmi.13320

Naert, G., Pasdelou, M. P., & Le Prell, C. G. (2019). Use of the guinea pig in studies on the development and prevention of acquired sensorineural hearing loss, with an emphasis on noise. The Journal of the Acoustical Society of America, 146(5), 3743. https://doi.org/10.1121/1.5132711

Rogers, K. (2012). Scientific modeling. In Encyclopædia Britannica. Retrieved from https://www.britannica.com/science/scientific-modeling

Springer Handbook of Model-Based Science (pp. 857-878). Switzerland: Springer.

Stanford Libraries (a). (n.d.). Stanford Prison Experiment. August 15-21, 1971. About the Stanford Prison Experiment. Retrieved from https://exhibits.stanford.edu/spe

Stanford Libraries (b). (n.d.). Stanford Prison Experiment. August 15-21, 1971. Philip G. Zimbardo. Retrieved from https://exhibits.stanford.edu/spe/about/philip-g-zimbardo

Sterrett, S. G., (2005). Kinds of Models. Based on a contribution to a panel discussion: STS

Interdisciplinary Roundtable: The Multiple Meanings of Models. John Hope Franklin Center, Duke University, Durham NC.

Sterrett, S. G., (2017). Experimentation on Analogue Models. In L. Magnani and T. Bertolotti, eds.

Weindling, P., von Villiez, A., Loewenau, A., & Farron, N. (2016). The victims of unethical human experiments and coerced research under National Socialism. Endeavour, 40(1), 1–6. https://doi.org/10.1016/j.endeavour.2015.10.005

Zimbardo, P. G., Maslash C. & Haney C. (2000). Reflections on the Stanford Prison Experiment: Genesis, Transformations, Consequences. Obedience to Authority: Current Perspectives on the Milgram Paradigm, ch.11. Editor: T. Blass. Publisher: Lawrence Erlbaum.