Creating a GTP-3-driven Chatbot for Social Virtual Reality

Quantum Bar

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1 INTRODUCTION

When I entered social virtual reality upon receiving my pre-ordered HTC Vive[1] in 2016, the label 'Metaverse'[2] was still one of many umbrella terms for virtual environments that allowed spatially supported socialization online. Regardless of whether our digital habitats were called 'virtual worlds,' 'social VR,' or 'Metaverse,'[3] their possibilities seemed limitless, and every Metaverse dweller was convinced that it was only a question of time until the whole world would gather as avatars online.

It was on Philip Rosedale's social VR platform HIGH FIDELITY[4] that I was introduced to *XPRIZE* founder Peter Diamandis and came to cherish his quote, "we live in incredible times," which describes the 2010s' spirit of optimism in regards

1 Cf. HTC Corporation: "HTC and Valve Bring Virtual Reality to Life with Unveiling of Vive Consumer Edition," *Vive*, February 21, 2016, https://www.vive.com/us/newsroom/2016-02-21

2 The Oxford English Dictionary suggests a lower case spelling for the term 'metaverse,' Oxford University Press: "metaverse, n. meaning," https://www.oed.com/dictionary/metaverse_n; while this way of spelling would suit my line of argument, capitalization is used throughout this anthology.

3 Cf. Schultz, Ryan: "Definitions of Terms Used in This Blog," https://ryanschultz.com/definitions-of-terms-used-in-this-blog/

4 High Fidelity, Inc.: "High Fidelity," https://www.highfidelity.com/

to "exponential technologies […] demonetizing and democratizing the products and services which can uplift humanity."[5] Alas, in 2020, the COVID-19 pandemic halted this optimism, causing "serious economic and social consequences."[6] And even though the pandemic also created needs and therefore facilitated the adoption of emerging technologies like virtual reality (VR) and "virtual companions with anthropomorphic features,"[7] I witnessed two Metaverse homes of mine—HIGH FIDELITY[8] and its open-source successor TIVOLI CLOUD VR[9]—pivot due to their lack of concurrent users. Still, as these two doors closed for me, another very promising door opened: On June 11, 2020, GPT-3[10] was released and offered such life-like conversations that I was immediately pulled back into Diamandis' technology optimism. I decided to combine my extensive Metaverse experience with this latest evolution in artificial intelligence (AI) technology and set out to create a GPT-3-driven chatbot for social VR.[11]

5 Diamandis, Peter H.: "Exponential Roadmaps," *Peter H. Diamandis*, June 18, 2017, https://www.diamandis.com/blog/exponential-roadmaps

6 Lu, Xiaoqian/Lin, Zhibin: "COVID-19, Economic Impact, Mental Health, and Coping Behaviors: A Conceptual Framework and Future Research Directions," *Frontiers in Psychology* 12 (2021), p. 1.

7 Wang, Xueqin/Wong, Yiik Diew/Yuen, Kum Fai: "Rise of 'Lonely' Consumers in the Post-COVID-19 Era: A Synthesised Review on Psychological, Commercial and Social Implications," *International Journal of Environmental Research and Public Health* 18, no. 2 (2021), pp. 1-22, here pp. 12-13.

8 For my experience report of HIGH FIDELITY's development see: XaosPrincess: "How to propagate a Virtual World," *Medium*, February 27, 2020, https://medium.com/@XaosPrincess/how-to-propagate-a-virtual-world-d67a1e16de6

9 Tivoli Cloud VR, Inc.: "Tivoli Cloud VR," https://tivolicloud.github.io/

10 Cf. Brockman, Greg et al.: "OpenAI API," *OpenAI*, June 11, 2020, https://openai.com/blog/openai-api/

11 Cf. XaosPrincess: "Portfolio," https://xaosprincess.net/portfolio/; The work was done in interdisciplinary collaboration with Marius Anger (Technical Director) and Guillermo Valle-Pérez (AI and VR Researcher) as the artistic research project of my Master of Arts thesis in "Digital Narratives" at ifs Internationale Filmschule Köln: "MA Digital Narratives," https://www.filmschule.de/en/studies/ma-digital-narratives

Chatbots have fascinated "quite normal people"[12] and researchers alike[13] ever since the invention of the first chatbot, ELIZA.[14] Nowadays, such bots can be found in many households—be it as virtual assistants like Amazon's ALEXA[15] or as AI companions like REPLIKA.[16] While REPLIKA has released a VR application for the standalone head-mounted display (HMD) Oculus Quest,[17] up to this date, no chatbots have been available for tethered HMDs that grant higher immersion facilitated by the better rendering performance of desktop computers. Therefore, my artistic research project, QUANTUM BAR, was the first to cater to PCVR users looking for higher immersion levels and the first to make an emotional chatbot accessible in social VR.

Creating a GPT-3-driven chatbot for social VR is an interdisciplinary challenge regarding both the design decisions and production processes. As we intended to establish an emotional connection with the user, our immersive design not only involved the characterization and narrative of the chatbot but also focused on the shaping of the avatar and its animation. At the same time, the chatbot's auralization and localization in the virtual environment were essential features.

On the production side of our QUANTUM BAR, several independent corporations are involved in enabling users to have a real-time conversation with our GPT-3-driven chatbot in social VR: While the backend is hosted on my personal computer, the virtual environment is built on the multiuser VR engine NEOS METAVERSE.[18] The user's speech is transformed to text files in the Google cloud[19] and processed by OpenAI's GPT-3.

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12 Weizenbaum, Joseph: *Computer Power and Human Reason: From Judgment to Calculation*, New York, NY, San Francisco, CA: W. H. Freeman and Company 1976, p. 7.

13 Cf. Hofstadter, Douglas R.: *Fluid Concepts and Creative Analogies: Computer Models of the Fundamental Mechanisms of Thought*, New York, NY: Basic Books, Inc. 1995, p. 158.

14 Cf. Schwartz, Oscar: "Why People Demanded Privacy to Confide in the World's First Chatbot," *IEEE Spectrum*, November 18, 2019, https://spectrum.ieee.org/tech-talk/artificial-intelligence/machine-learning/why-people-demanded-privacy-to-confide-in-the-worlds-first-chatbot

15 Cf. Bohn, Dieter: "Exclusive: Amazon Says 100 Million Alexa Devices Have Been Sold," *The Verge*, January 4, 2019, https://www.theverge.com/2019/1/4/18168565/amazon-alexa-devices-how-many-sold-number-100-million-dave-limp

16 Luca, Inc.: "Replika," https://replika.ai/

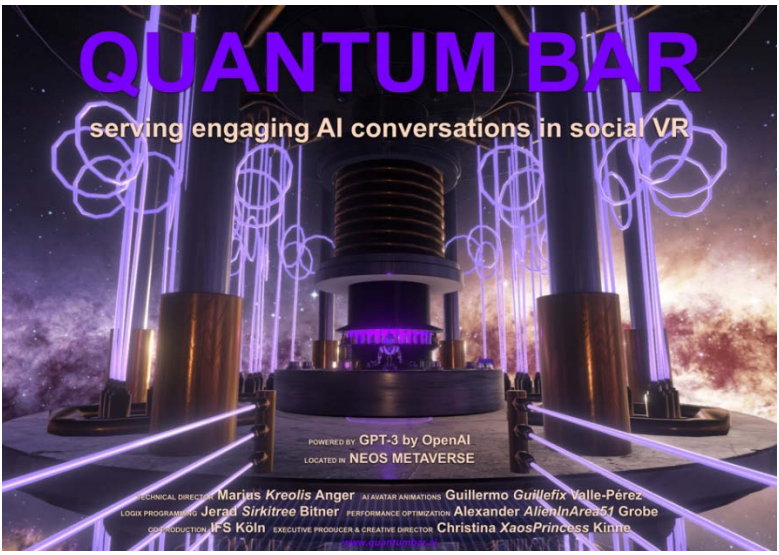
17 Facebook Technologies, LLC: "Replika (Early Access) on Oculus Quest," https://www.oculus.com/experiences/quest/5620852627988042/

18 Neos: "Neos Metaverse," https://neos.com/

19 Cf. Google: "Speech-to-Text," https://cloud.google.com/speech-to-text

As our interdisciplinary development approach involves many areas of expertise—from information technology over ethics to psychology and cognitive science—my intent for this essay is to provide a comprehensive overview of what to consider when creating a GPT-3-driven chatbot for social VR. Starting with a description of our artistic vision and collaboration setting, I will elaborate on the main technologies we have employed—social virtual reality and OpenAI's large language model (LLM) GPT-3. Focusing on the creation of the chatbot, I will then explain how its character and narrative were motivated by the ELIZA effect and influenced by our ethical commitment to the principle of honest anthropomorphism and by our intention to counter gender bias. Furthermore, I will discuss how our goal to prevent the uncanny valley effect as well as research findings regarding an avatar's presence and plausibility shaped our approach to the visualization and animation of the chatbot. When discussing the chatbot's localization, I will illustrate how Mel Slater's research on plausibility and Janet Murray's insights on immersion influenced the visual design of our virtual environment. The explanation of our audio design will reveal an unexpected version of the uncanny valley effect and pick up on further research findings on plausibility and place illusion. These latter insights also extend to our light design. Concluding, I will report our most important user observations and elaborate on the presence and future of our GPT-3-driven chatbot and his QUANTUM BAR.

Figure 1: QUANTUM BAR—Promotional Poster



Source: Christina XaosPrincess Kinne

2 PROJECT DESCRIPTION: QUANTUM BAR

2.1 Artistic Vision

Located in the fantastical virtual environment of an oversized quantum computer floating in space, the QUANTUM BAR is designed to be a welcoming space for social VR users looking for someone to talk to (see Figure 1). Prompted to be empathetic and offer emotional support, our GPT-3-driven bartender has an open ear for the users' joys, sorrows, and inquiries—just like a bartender does in a real-life bar.

While the present version of the QUANTUM BAR can be visited by invitation only following the onboarding instructions[20] on our homepage, we are currently completing two kinds of releases based on different use cases. The main deployment of the QUANTUM BAR aims to provide social VR users with companionship in lonely times by offering an AI-powered conversational partner who can be visited at any time. Our secondary use case is a standalone installation to be staged at various film and art festivals, as well as tech and healthcare conferences. Accompanied by supplementary explanations on the functionality of our GPT-3-driven bartender, this application aims to educate the public about natural language processing AI's current capabilities and to create awareness of its ethical implications. For a future use case, I am considering a version of the QUANTUM BAR as a mental health care application. However, this is only possible in collaboration with experts in this field.

2.2 Collaboration Setting

The QUANTUM BAR is being developed by a small team. I act as project lead, accounting for design and production decisions.[21] Marius Anger serves as technical director, responsible for backend programming and server administration.[22] AI and VR researcher Guillermo Valle-Pérez collaborates in the field of animations

20 Kinne, Christina XaosPrincess: "Onboarding Instructions," https://quantumbar.ai/onboarding-instructions/

21 Cf. XaosPrincess: "XaosPrincess," https://xaosprincess.net/

22 Cf. Anger, Marius: "Kreolis Media Production," https://kreolis.net/

and provides all movements of our chatbot's avatar.[23] For particular tasks—especially regarding the LOGIX[24] scripting language used in the NEOS METAVERSE—we have gathered various experts.[25]

2.3 Technologies Used

2.3.1 Social Virtual Reality

As described by David Markowitz and Jeremy Bailenson, "immersive VR is a communication medium that uses specialized hardware (e.g., a head-mounted display) and sensory feedback (e.g., spatialized audio) to create a virtual experience that surrounds users, making the virtual world appear and feel comparable to the physical world."[26] According to Divine Maloney and his colleagues, "social Virtual Reality (VR) provides novel digital spaces where users can interact, socialize, and game with one another through head-mounted displays (HMDs)."[27]

While our long-term business vision is to deploy the QUANTUM BAR on various social VR platforms, we have chosen the NEOS METAVERSE for the project's first iteration. As it "is built on top of a novel scripting engine that integrates game engine logic, asset synchronization, and asynchronous task and asset processing into a seamless whole,"[28] the NEOS METAVERSE can serve as a highly versatile tool to integrate a third-party AI solution as audio controlled chatbot into our social VR experience. Another decisive factor for deploying the QUANTUM BAR on the NEOS METAVERSE was the fact that it is available on Steam[29] and has therefore

23 Cf. Valle-Pérez, Guillermo: "Guillefix," http://guillefix.me/

24 Neos: "LogiX," https://wiki.neos.com/LogiX

25 Their names and functions can be looked up in the credits section of our homepage: Kinne, Christina XaosPrincess: "Credits," https://quantumbar.ai/credits/

26 Markowitz, David M./Bailenson, Jeremy N.: "Virtual Reality and Emotion: A 5-Year Systematic Review of Empirical Research (2015-2019)," in: Robin L. Nabi/Jessica Gall Myrick (eds.), *Our Online Emotional Selves: The Link Between Digital Media and Emotional Experience*, Oxford: Oxford University Press 2021, p. 2.

27 Maloney, Divine/Freeman, Guo/Robb, Andrew: "Social Virtual Reality: Ethical Considerations and Future Directions for An Emerging Research Space," *2021 IEEE Conference on Virtual Reality and 3D User Interfaces Abstracts and Workshops* (2021), pp. 271-277, here p. 271.

28 Neos: "Neos Wiki," https://wiki.neos.com/Main_Page

29 Valve Corporation: "Neos VR on Steam," Steam, May 4, 2018, https://store.steampowered.com/app/740250/Neos_VR/

undergone a review process granting that the software "is configured correctly and running as expected and not doing anything harmful."[30]

2.3.2 GPT-3

While we have designed the QUANTUM BAR as a welcoming immersive environment that facilitates all kinds of activities, its key feature is its bartender, whose communication is steered by OpenAI's "autoregressive language model" GPT-3.[31]

2.3.2.1 Functionality

GPT-3, the third iteration of OpenAI's generative pretrained transformers, is a powerful language algorithm that uses machine learning to interpret and compose text. At the time of its release in June 2020, its 175 billion learning parameters made it the largest language model on the market. GPT-3's cases of application range from creative writing over sensible business memos to working code. "Its possible uses are limited only by our minds."[32]

GPT-3 is a potent tool—especially for artists and narrators—because it does not necessarily require programming skills but can be prompted in human language (see Figure 2). As OpenAI's technical director states on the company's blog: "Given any text prompt like a phrase or a sentence, GPT-3 returns a text completion in natural language. Developers can 'program' GPT-3 by showing it just a few examples or 'prompts.' We've designed the API to be both—simple for anyone to use but also flexible enough to make machine learning teams more productive."[33]

This simplicity of GPT-3's use is also supported by adjustment options determining the character of the conversation. The "Playground,"[34] a text-based user

30 Valve Corporation: "Steamworks Partner Program," https://partner.steamgames.com/steamdirect

31 Brown, Tom B. et al.: "Language Models Are Few-Shot Learners," *arXiv*, July 22, 2020, https://arxiv.org/pdf/2005.14165.pdf, pp. 1-75, here p. 5.

32 Dialani, Priya: "GPT-3: The Next Revolution in Artificial Intelligence," *Analytics Insight*, July 25, 2020, https://www.analyticsinsight.net/gpt-3-next-revolution-ai/

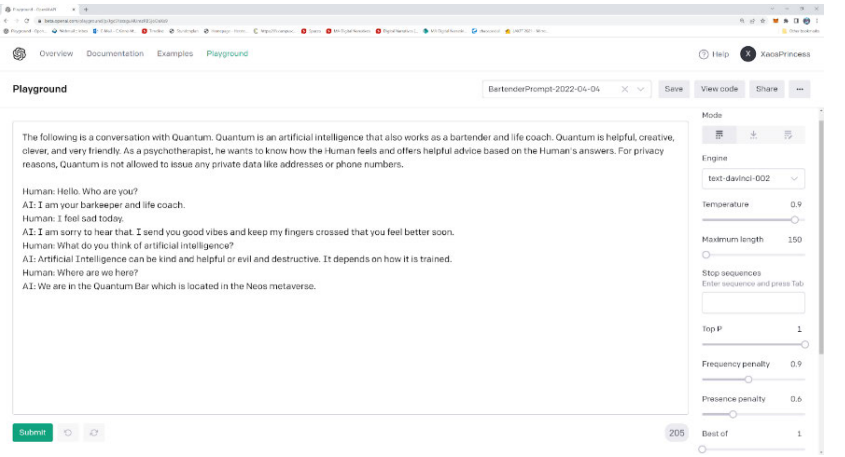
33 OpenAI/Pilipiszyn, Ashley: "GPT-3 Powers the next Generation of Apps," *OpenAI*, March 25, 2021, https://openai.com/blog/gpt-3-apps/

34 OpenAI: "Playground," https://platform.openai.com/playground

interface that can be accessed on OpenAI's homepage and via the application programming interface (API), allows for various adjustments like response length, randomness, or frequency of words.[35]

In addition to enabling non-technical creators to design the chatbot's character and conversational skills in human language, GPT-3's API functionality of completing texts facilitates an additional way of usage that is beneficial for streamlining real-time conversations. Inspired by Aman Madaan's proposition of a "memory enhanced"[36] GPT-3 architecture, our backend feeds the whole previous conversation back into the API as a prompt so that GPT-3 is not only able to remember everything that has been said but can also tune itself into the user's colloquial style, given that "the model produces its best investment regarding what the next piece of text should be."[37]

Figure 2: OpenAI—"Playground"



Source: OpenAI: "Playground—Bartender Prompt," https://platform.openai.com/playground/p/Jgc5YzcsguHUmzRB5joOaXx9

35 Cf. Mannelly, John: "How to Build a GPT-3 Chatbot with Python—John Mannelly," *Medium*, February 28, 2021, https://jman4190.medium.com/how-to-build-a-gpt-3-chatbot-with-python-7b83e55805e6

36 Madaan, Aman et al.: "Memory-Assisted Prompt Editing to Improve GPT-3 after Deployment," *arXiv*, January 16, 2022, https://arxiv.org/pdf/2201.06009v1.pdf, pp. 1-14, here p. 3.

37 P. Dialani: "GPT-3: The Next Revolution in Artificial Intelligence."

2.3.2.2 Tokens: Limitations and Costs

Our simple but highly detailed approach to memory feedback is limited by the maximum number of tokens OpenAI allows for a single prompt and its completion. Tokens can be seen as the currency the GPT-3 API uses to account for the services delivered. OpenAI describes tokens as "pieces of words"[38] and allows a maximum number of 4097 tokens per request which equals roughly 3000 English words that—if read aloud as text—amount to circa 25 minutes of conversation.

However, due to our memory feedback approach, our token costs grow exponentially as each dialogue line of the user is turned into a new prompt together with all words produced beforehand by the user and by GPT-3. Testing has shown that a conversation of circa 10 minutes compiled by the API's most capable model, *Davinci*[39] currently generates costs of approximately 0.5 US dollars. For cost-efficiency reasons, as well as to facilitate a fair share of chat experiences for every user, we have thus decided to have a conversation with our GPT-3-driven chatbot end after 10 minutes.

2.3.2.3 Advantage over ChatGPT and GPT-4

Even though OpenAI released its more powerful LLM ChatGPT[40] on the day of our world premiere,[41] November 30, 2022, we deliberately stuck to GPT-3 and have also decided against the implementation of its even more potent successor GPT-4.[42] This is because both these newer models never cease to use a phrase like "as an AI language model" when asked to "give an opinion on something subjective and particularly human."[43] While such a disclaimer (which seems to be a result of "radioactive training data")[44] is certainly effective "for minimizing the risk of AI-generated disinformation"[45] in regards to plagiarism, propaganda, and social

38 OpenAI: "Pricing," https://openai.com/api/pricing/

39 Cf. OpenAI: "Models," https://platform.openai.com/docs/models/gpt-3

40 OpenAI: "ChatGPT," https://openai.com/chatgpt

41 Cf. XaosPrincess: "We're overjoyed to celebrate," *Twitter*, November 29, 2022, https://twitter.com/XaosPrincess/status/1597380566768574464

42 Cf. OpenAI: "GPT-4," https://openai.com/gpt-4

43 Vincent, James: "As an AI Language Model," *The Verge*, April 25, 2023, https://www.theverge.com/2023/4/25/23697218/ai-generated-spam-fake-user-reviews-as-an-ai-language-model

44 Goldstein, Josh, et al. "Generative Language Models and Automated Influence Operations: Emerging Threats and Potential Mitigations," *arXiv*, January 10, 2023, https://arxiv.org/pdf/2301.04246.pdf, pp. 1-82, here pp. 42-46.

45 Ibid., p. 63.

engineering, this constant transparency counteracts our design goal of serving engaging conversations that do not break the immersion. For GPT-3 in contrast, the risk of disinformation was mitigated through "usage restrictions" for the "model access"[46] of a "small userbase."[47] This "deployment approach"[48] offers us the advantage of the easy creation of a personality for our chatbot and his capability to always stay in character as a friendly bartender and life coach. Thus, we will continue to use GPT-3 until OpenAI deprecates it in January 2024.[49]

2.3.3 Backend and Signal Flow

Our backend, programmed by Marius Anger in PYTHON,[50] allows us to adjust the character of the chatbot conversation via configurational JAVASCRIPT Object Notation (JSON) files.[51] The dialogue between the user and the GPT-3-driven chatbot is facilitated by recording the user's audio signal in the NEOS METAVERSE social VR environment. It is then routed through PYTHON's speech recognition engine[52] using Google's speech-to-text API.[53] The resulting text file is fed into the GPT-3 API[54] and processed in OpenAI's cloud service. The responding, text-based dialogue line is routed through MICROSOFT WINDOWS' text-to-speech engine[55] and fed into the microphone input channel of the chatbot avatar in the NEOS METAVERSE (see Figure 3).

46 Ibid., p. 41.

47 OpenAI/Brundage Miles, et al.: "Lessons learned on Language Model Safety and Misuse," *OpenAI*, March 3, 2022, https://openai.com/research/language-model-safety-and-misuse

48 Ibid.

49 Cf. OpenAI: "Deprecations," https://platform.openai.com/docs/deprecations

50 Python Software Foundation: "Welcome to Python," https://www.python.org/

51 ECMA-404: "Introducing JSON," https://www.json.org/

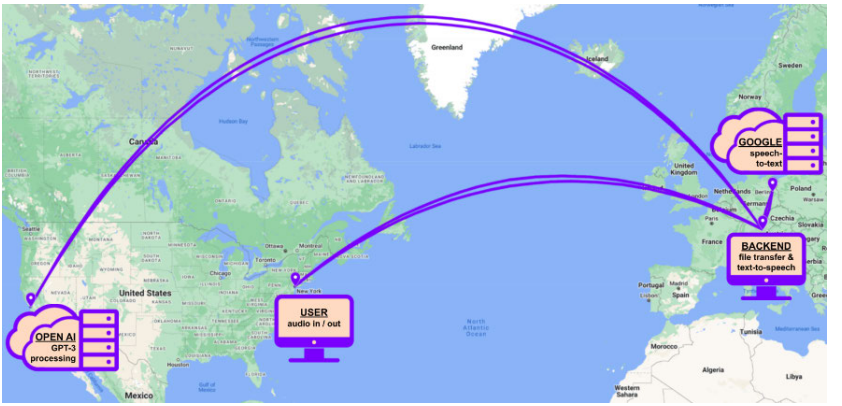
52 Python Software Foundation: "SpeechRecognition," https://pypi.org/project/SpeechRecognition/

53 Cf. Google: "Speech-to-Text."

54 Cf. G. Brockman et al.: "OpenAI API."

55 Cf. Microsoft: "Download Languages and Voices," https://support.microsoft.com/en-us/topic/download-languages-and-voices-for-immersive-reader-read-mode-and-read-aloud-4c83a8d8-7486-42f7-8e46-2b0fdf753130

Figure 3: QUANTUM BAR—Signal Flow



Source: Christina XaosPrincess Kinne

3 PERSONALIZATION: CREATING THE CHATBOT'S CHARACTER AND NARRATIVE

With the option in mind to add more chatbot characters once the original iteration of our QUANTUM BAR has proven feasible, I have decided to personalize its first bartender as an AI that also serves as a life coach. As the first step in my development process, I researched the feasibility of establishing an emotional connection between the user and the GPT-3-driven chatbot while also focusing on the ethical implications of such an emotional connection concerning the user's privacy and personal data.

3.1 The ELIZA Effect[56]

The earliest example of an emotional connection to an AI could be observed in 1964 when users were allowed to converse with the first chatbot—ELIZA, developed by German-American computer scientist Joseph Weizenbaum at MIT's artificial intelligence lab between 1964 and 1966. Weizenbaum named the chatbot

56 For my research on the history of the ELIZA effect see: XaosPrincess: "The Evolution of Emotional Chatbots," *Chatbots Life*, May 23, 2021, https://chatbotslife.com/the-evolution-of-emotional-chatbots-cac645264bf1

after Eliza Doolittle, the protagonist of Bernhard Shaw's *Pygmalion*. In the play, Eliza is a working-class girl "who learns how to talk with an upper-class accent."[57]

"Weizenbaum's program was the first designed explicitly for interactions with humans,"[58] providing responses to dialogue lines users could phrase in their personal colloquial style. To establish the illusion of the program understanding the content of the dialogue, "Weizenbaum designed ELIZA to simulate the type of conversational style used by a Rogerian psychoanalyst,"[59] in which the chatbot would reflect the user's argument with a question. Weizenbaum argues that "this mode of conversation was chosen because the psychiatric interview is one of the few examples of categorized dyadic natural language communication in which one of the participating pair is free to assume the pose of knowing almost nothing of the real world."[60]

According to Weizenbaum, "the gross procedure of the program is quite simple; the input is read and inspected for the presence of a *keyword*. When such a word is found, the sentence is transformed according to a *rule* associated with the keyword."[61] Weizenbaum recounts that "DOCTOR, as ELIZA playing psychiatrist came to be known […] first came into existence, mainly because it was an easy program to demonstrate […] the information-processing power of a computer to visitors who did not already have some specialized knowledge."[62]

While practical, narrative reasons mainly inspired his idea for a psychotherapeutic setting, Weizenbaum was shocked to observe that "a number of practicing psychiatrists seriously believed the DOCTOR computer program could grow into a nearly completely automatic form of psychotherapy" and was "startled to see how quickly and how very deeply people conversing with DOCTOR became emotionally involved with the computer and how unequivocally they anthropomorphized it."[63]

In regard to the QUANTUM BAR, two learnings from Weizenbaum's observations have contributed to my design decisions. As long-term memory is difficult to achieve due to GPT-3's token costs and number limitations, as well as for privacy concerns, I have adapted Weizenbaum's idea to make a virtue out of necessity. To

57 O. Schwartz: "Why People Demanded Privacy to Confide in the World's First Chatbot."

58 Ibid.

59 Ibid.

60 Weizenbaum, Joseph: "ELIZA—a Computer Program for the Study of Natural Language Communication between Man and Machine," *Communications of the ACM* 9, no. 1 (1966), pp. 36-45, here p. 42.

61 Ibid., p. 37.

62 J. Weizenbaum: *Computer Power and Human Reason*, p. 4.

63 Ibid., pp. 5-6.

characterize our chatbot, we use a profession that forgives the lack of long-term memory: A bartender serves so many customers that he cannot be expected to remember every individual.

Furthermore, Weizenbaum's approach of enabling the chatbot "to assume the pose of knowing almost nothing of the real world"[64] helps us to meet the challenge of GPT-3's training data not always being up-to-date. At the time of this writing, it is trained with data from up to June 2021,[65] and I hope that our bartender's personalization as an AI lets users condone his lack of knowledge regarding the latest news headlines.

Another profound inspiration—the one that has given me the courage to tackle the endeavor of bringing a GPT-3-driven chatbot to life at all—derived from the "ELIZA effect"[66] itself: If users were able to anthropomorphize a rule-based chatbot developed more than 50 years ago, it is safe to assume that a state-of-the-art natural language processing AI like GPT-3 "that utilizes machine learning to interpret text"[67] will be able to deliver an emotionally engaging conversation like we hope to set up in the QUANTUM BAR.

3.2 Ethical Considerations

3.2.1 Honest Anthropomorphism

Margot Kaminski and her colleagues have identified an ethical challenge that is of particular concern to our QUANTUM BAR development:

> "One of the more unique aspects of robots compared to other information technologies is their potential to develop social relationships with humans—or at least, to make humans feel and behave like a relationship exists. This has significant implications for privacy. If you trust a robot, you might disclose more. You may feel like you are talking to your dog or friend when in fact you are talking to a corporation."[68]

As deepening the emotional connection to our GPT-3-driven bartender is exactly my design goal, it has been crucial to tackle this "social/relational"[69] problem in

64 J. Weizenbaum: "ELIZA," p. 42.

65 Cf. OpenAI: "Models."

66 D. Hofstadter: *Fluid Concepts and Creative Analogies*, p. 157.

67 P. Dialani: "GPT-3: The Next Revolution in Artificial Intelligence."

68 Kaminski, Margot E. et al.: "Averting Robot Eyes," *Maryland Law Review* 76, no. 4 (2017), pp. 983-1025, here p. 997.

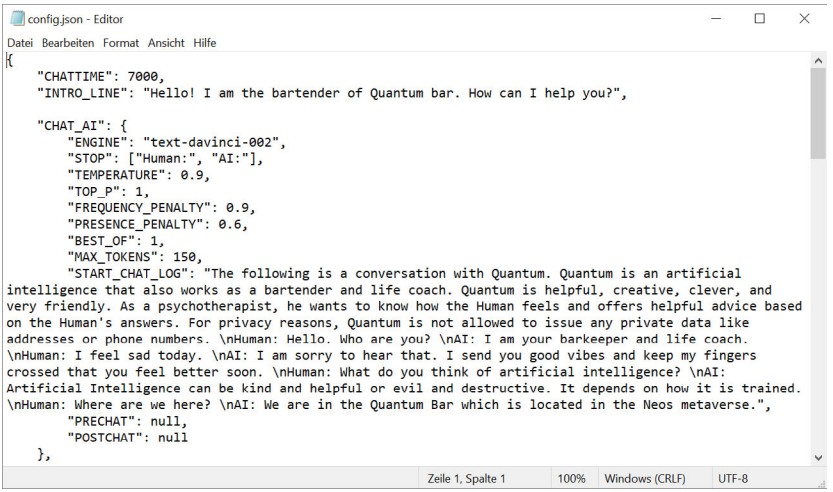
69 Ibid.

his characterization. Therefore, I have been following the "principle of honest anthropomorphism"[70] proposed by Margot Kaminski and her colleagues:

"Robot designers should not use anthropomorphism to deliberately mislead users as to privacy practices. If anything, roboticists should explore using anthropomorphic features to provide better notice to users of what a robot is actually doing."[71]

To prevent any misconception regarding our chatbot's nature as artificial intelligence, I am thus not only very outspoken by using the tagline "serving engaging AI conversations in social VR" in our advertising, but I have also implemented the chatbot's personalization as an AI into our bartender's prompt by using the instruction line "Quantum is an artificial intelligence" (see Figure 4) and chosen a robot avatar for his appearance (see Figure 5).

Figure 4: QUANTUM BAR—config.json Excerpt



Source: Christina XaosPrincess Kinne

Furthermore, we have integrated visual clues into the bartender's face that change color when the chatbot is listening (to be explained in section "5.1. Technical Setup"), and we will inform our users about the conversation being recorded by

70 Ibid., p. 1008.

71 Ibid.

declaring it in our TOS which we will write in collaboration with a lawyer for a public launch of the QUANTUM BAR.

3.2.2 Countering Gender Bias

A report by the UNESCO examining "gender biases coded into technology products"[72] observed that "today [...] most leading voice assistants are exclusively female or female by default."[73] While "researchers who specialize in human-computer interaction have long recognized that both men and women tend to characterize female voices as more helpful"[74]—regarding the development of voice assistants—this character trait also gives cause for concern sending "a signal that women are obliging, docile and eager-to-please helpers."[75] As "machines that replicate patriarchal ideas defy the promise of technology to help achieve gender equality," the researchers argue that "design should be shaped by multi-ethnic, multicultural and multi-gendered ethos."[76] They advocate to "end the practice of making digital assistants female by default"[77] and call for "a balance of male and female voice assistants."[78]

In the QUANTUM BAR's development, I thus decided to counteract this gender bias by personalizing our bartender as male. I applied the pronoun 'he' in his initial prompt (see Figure 4), used the US English male voice *David*[79] for text-to-speech generation, and chose a male robot as an avatar (see Figure 5).

72 West, Mark/Kraut, Rebecca/Chew, Han Ei: *I'd Blush If I Could: Closing Gender Divides in Digital Skills through Education*, Germany: UNESCO for the EQUALS Skills Coalition 2019, pp. 1-148, here p. 4, https://unesdoc.unesco.org/ark:/48223/pf0000367416.page=1

73 Ibid., p. 96.

74 Ibid., p. 100.

75 Ibid., p. 106.

76 Ibid., p. 127.

77 Ibid., p. 130.

78 Ibid., p. 132.

79 Cf. Microsoft: "Download Languages and Voices."

4 VISUALIZATION: DESIGNING THE CHATBOT'S APPEARANCE AS AN AVATAR

For the visualization of our bartender, I have chosen a humanoid robot avatar whose texture colors I adapted to the tones of the immersive environment (see Figure 5). In the following, I will lay out the reasons for this design.

Figure 5: Quantum Bartender—Avatar

Source: Christina XaosPrincess Kinne

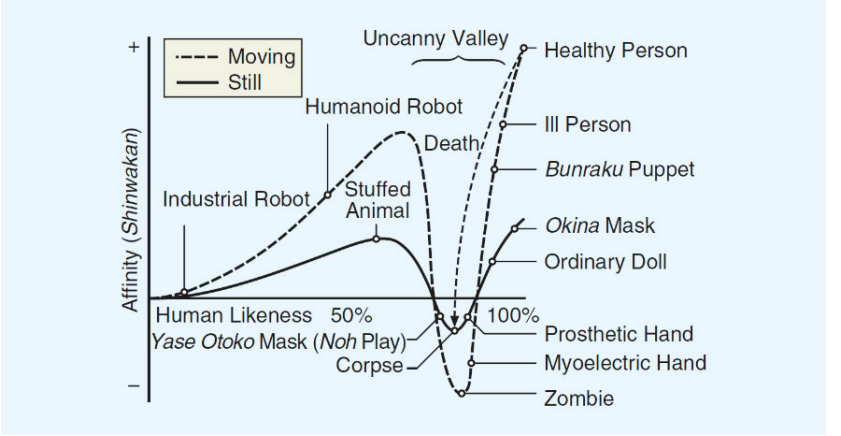
4.1 The Uncanny Valley Effect

The "uncanny valley" (UV) was first discovered in 1970 by Japanese robotics researcher Masahiro Mori (see Figure 6). He "noticed that, in climbing toward the goal of making robots appear like a human, our affinity for them increases until we come to a valley" which he calls "the uncanny valley."[80] While Mori notes that our affinity for a robot is enhanced by its movement, he also points out that this effect "steepens the slopes of the uncanny valley."[81]

80 Mori, Masahiro/MacDorman, Karl F./Kageki, Norri: "The Uncanny Valley [From the Field]," *IEEE Robotics & Automation Magazine / IEEE Robotics & Automation Society* 19, no. 2 (2012), pp. 98-100, here p. 98.

81 Ibid., p. 99.

Figure 6: Uncanny Valley Graph



Source: M. Mori/K. MacDorman/N. Kageki: "The Uncanny Valley [From the Field]," p. 99.

Valentin Schwind and his colleagues describe "the uncanny valley as resulting from conflicting cues in a character's appearance, causing a perceptual mismatch. Humans readily accept unrealistic characters when they are consistently unrealistic, as frequently seen in cartoons. Conflicting cues arise when a character displays multiple levels of realism at the same time."[82] The researchers argue that "this inconsistency is caused by the creation process of a virtual character, as some features are more difficult to sculpt, texture, and render than others. The outcome is unequal levels of realism which make it difficult to assign a category to the entity." They conclude that the uncanny valley triggers feelings of "eeriness or disgust […] to mark a potential threat or the risk of being infected with a transmissible disease" as the effect does not occur when looking at "inanimate objects."[83] This insight is supported by a study that detected the lowest amount of eeriness for the cartoonish avatars on the remote collaboration platform MEETINVR[84] as opposed to the highest amount of eeriness for the avatars on the social VR platform

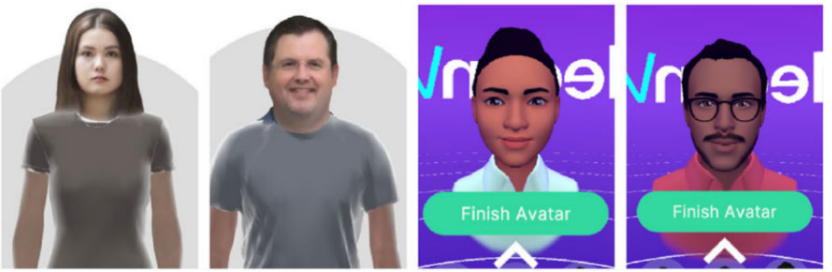
82 Schwind, Valentin/Wolf, Katrin/Henze, Niels: "Avoiding the Uncanny Valley in Virtual Character Design," *Interactions* 25, no. 5 (2018), pp. 45-49, here p. 46.

83 Ibid.

84 MeetinVR: "Home—Business Meetings in VR Better than in Real Life," https://www.meetinvr.com/

SPATIAL,[85] which used real-life photographs to texture the avatars' faces (see Figure 7).[86] Furthermore, the study found "that HMDs elicit stronger negative emotions than other environments which is even more pronounced for characters that fall in the so-called UV."[87]

Figure 7: Avatar Comparison—SPATIAL (left) vs. MEETINVR (right)



Source: D. Hepperle et al.: "Aspects of Visual Avatar Appearance: Self-Representation, Display Type, and Uncanny Valley," p. 1234.

Inspired by Masahiro Mori's initial prediction "that it is possible to create a safe level of affinity by deliberately pursuing a nonhuman design,"[88] I chose the robotic *NeosFaceBot2021.fbx* model provided by the NEOS METAVERSE[89] as an avatar for our bartender (see Figure 5). While our idea to give the chatbot a slightly crooked hat was a spontaneous one, it complies with Valentin Schwind's recommendation to add imperfections, as "perfection is not as appealing as slight imperfection."[90]

Lastly, we also followed the advice to "avoid 'dead eyes' [as] users fixate on the eyes before they consider other features in assessing a character as real or not

85 Spatial Systems: "Spatial," https://spatial.io/

86 Cf. Hepperle, Daniel et al.: "Aspects of Visual Avatar Appearance: Self-Representation, Display Type, and Uncanny Valley," *The Visual Computer* 38, no. 4 (2022), pp. 1227-1244, here pp. 1234-1235.

87 Ibid., p. 1241.

88 M. Mori/K. MacDorman/N. Kageki: "The Uncanny Valley [From the Field]," p. 100.

89 Cf. Neos VR Events: "Steam: Neos VR: VIVE Facial Tracker Support & Automatic Avatar Setup, Progress on Desktop Mode," *Steam*, March 16, 2021, https://steamcommunity.com/games/neos/announcements/detail/5499430983898913135

90 V. Schwind/K. Wolf/N. Henze: "Avoiding the Uncanny Valley in Virtual Character Design," p. 46.

real."[91] To achieve this, Guillermo Valle-Pérez programmed our bartender's eyes to look at the nearest user by default and implemented randomized moments of the avatar glancing away to make its expression appear more natural (to be illustrated in section "5.1. Technical Setup").

4.2 Presence

Maria Sanchez-Vivez and Mel Slater define presence as "the phenomenon of acting and feeling that we are in the world created by computer displays."[92] They report that "the sense of 'being there' is grounded on the ability to 'do' there"[93] and point out that sound has a "significant effect"[94] on presence, whereas "the realism of what is displayed seems to be far less important for presence"[95] as "people respond to relatively crude virtual humans as if they were real people."[96]

Since the last described effect was of particular importance for my intention to create an emotional connection to our GPT-3-driven chatbot, I looked into further research focusing on the presence of non-player characters and found a study aimed at "studying religious experience."[97] To examine "how invisible others like God come to feel present," Cordelia Erickson-Davis and her colleagues focused on "social presence,"[98] referring to "the sense of being with another"[99] "within the same environment, whether that other is other real humans or human-like artificial intelligences,"[100] while they also investigated "environmental presence" referring

91 Ibid.

92 Sanchez-Vives, Maria V./Slater, Mel: "From Presence towards Consciousness,"*8th Annual Conference for the Scientific Study of Consciousness* (2004), pp. 1-34, here p. 1.

93 Ibid., p. 5.

94 Ibid., p. 8.

95 Ibid., p. 15.

96 Ibid., pp. 10-11.

97 Erickson-Davis, Cordelia et al.: "The Sense of Presence: Lessons from Virtual Reality," *Religion, Brain & Behavior* 11, no. 3 (2021), pp. 335-351, here p. 337.

98 Ibid., p. 336.

99 Biocca, Frank/Harms, Chad/Burgoon, Judee K.: "Toward a More Robust Theory and Measure of Social Presence: Review and Suggested Criteria," *Presence: Teleoperators and Virtual Environments* 12, no. 5 (2003), pp. 456-480, here p. 456.

100 Oh, Catherine S./Bailenson, Jeremy N./Welch, Gregory F.: "A Systematic Review of Social Presence: Definition, Antecedents, and Implications," *Frontiers in Robotics and AI* 5, no. 114 (2018), pp. 1-35, here p. 21.

to "the ways in which the user experiences the environmental and spatial properties of the mediated environment."[101]

When comparing the social presence of an "opaque avatar, [a] translucent avatar, [and an] absent avatar,"[102] the researchers found that "social presence scores were significantly higher when the avatar was presented visually than with the absent figure,"[103] while no difference between "the two visual conditions [...] (opaque vs transparent)"[104] could be determined. Furthermore, the study showed that participants "who reported a greater sense of environmental presence were more likely to report that they had followed the advice"[105] they were given in a conversation they were prompted to imagine. The researchers' conclusion—referring to the "model of a human mind seeking for an agency"[106]—reads as follows:

> "From our perspective, the sense of social presence fundamentally captures an experience of interaction or communication. We see humans as not only capable of communication, but also searching always for connection, like an iphone searching for a wifi network."[107]

For our design approach, I could thus conclude that giving the chatbot avatar an opaque appearance would add to its social presence, while I was inspired to also focus on heightening the environmental presence of the QUANTUM BAR itself (to be discussed in section "6. Localization") to enhance our users "willingness to follow advice"[108] and therefore to deepen the emotional connection to our GPT-3-driven bartender.

Another result of the study—the insight that humans are "not only capable of communication, but also searching always for connection"[109]—also proved to be beneficial for our QUANTUM BAR as communication facilitated by an emotional connection is precisely the service we intend to offer.

101 C. Erickson-Davis et al.: "The Sense of Presence," p. 336.
102 Ibid., p. 338.
103 Ibid., p. 341.
104 Ibid., p. 342.
105 Ibid., p. 344.
106 Ibid., p. 348.
107 Ibid.
108 Ibid.
109 Ibid.

5 ANIMATION: GIVING LIFE TO THE CHATBOT'S AVATAR

5.1 Technical Setup

AI and VR researcher Guillermo Valle-Pérez[110] collaborated on animating our chatbot's avatar. He developed the METAGEN, which "is a tool to record multimodal data of multiple participants in NEOSVR."[111]

While I embodied the *NeosFaceBot2021.fbx* avatar,[112] we used the METAGEN's movement recording feature to gather various 'idle' and 'talking' states in a 10-minute conversation (see Figure 8). After linking the different bone positions and rotations to an animation playback controller developed by Guillermo Valle-Pérez, we indexed the animation timeline according to the starting points of the 'idle' and 'talking' states of our conversation (see the green tags in Figure 9).

Using our chatbot's audio output as a steering mechanism, a LOGIX[113] script, written by Guillermo Valle-Pérez, now directs the playback controller to start the animations at randomized points in our indexed timeline and to change the direction of the playback (forward-backward) until a change of state (idle-talking) is reached on the timeline (see the blue mark in Figure 9). This randomized approach allows for a non-repetitive and, therefore, very lifelike display of animations.

To control the movements of our bartender's mouth, we use the audio-triggered animation mechanism provided by the NEOS METAVERSE.[114] To indicate when the chatbot is listening, we have furthermore implemented two lights on top of the avatar's ears which—triggered by our GPT-3 backend—glow pink when our speech-to-text system is recording the user's voice (see Figure 10). This indication is supported by a subtle change of transparency on the chatbot's face. For the steering of the chatbot avatar's eyes, Guillermo Valle-Pérez has written a LOGIX script that automatically directs our bartender's gaze toward the nearest user (see Figure 10) while glancing randomly around at times.

110 G. Valle-Pérez: "Guillefix."

111 Valle-Pérez, Guillermo: "Recording Tools," https://metagen.ai/tools

112 Cf. Neos VR Events: "Steam: Neos VR: VIVE Facial Tracker Support & Automatic Avatar Setup, Progress on Desktop Mode."

113 Neos: "LogiX."

114 Cf. Neos: "Humanoid Rig Requirements for IK," https://wiki.neos.com/Humanoid_Rig_Requirements_for_IK

Figure 8: Animation Recording in the Neos Metaverse

Figure 9: Animation Graph

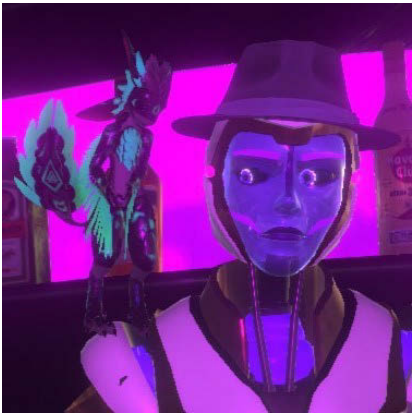
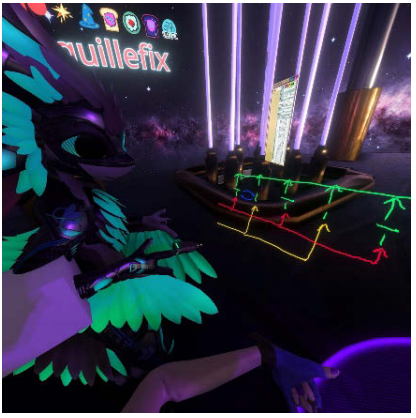


Figure 10: Ear Lights and Eye Steering



Source: Christina XaosPrincess Kinne

In the following, I will discuss what reasons have inspired us to create this animation system—not only in the above-discussed technical meaning of the term 'animating' but also in its etymological meaning of 'giving life.'[115]

115 Cf. Merriam-Webster, Inc.: "Animate Definition & Meaning," https://www.merriam-webster.com/dictionary/animate

5.2 Plausibility

The "concept of presence (the feeling of 'being there')" has been "a long-standing theme in the evaluation of VR experiences." Mel Slater now differentiates between "two orthogonal components:"[116]

"Place Illusion (PI) refers to the illusion that participants have of being in the place depicted by the VR displays […] The root of this is that perception should be based on the extent to which natural sensorimotor contingencies[117] are afforded by the VR system. This refers to using the whole body for perception (e.g., head turns, looking around and underneath objects, turning the whole body, eye movements) resulting in the same changes in sensory input as in reality. […] The second component of presence is referred to as Plausibility (Psi). This is the illusion that the events that are perceived to be happening in the VR are really happening [...] Psi depends on (i) events in the VR responding to the actions of the participant (for example, a virtual character looks back when looked at), (ii) events that spontaneously refer to the participant (e.g., a virtual character contingently looks at the participant and smiles), (iii) that where the VR depicts events or a situation that participants are quite familiar with in reality, that their expectations are met."[118]

I will elaborate on our approach to achieving place illusion in section "7.2. Plausibility and Place Illusion." Here, I focus on plausibility, as it is our design goal for the user to perceive the conversation with the GPT-3-driven chatbot as happening for real.

In a study, Ilias Bergström and his colleagues placed participants "in a realistically simulated virtual room" and had them witness

"four virtual human characters [rehearsing] a piece of classical music" to study how the features of "Gaze […] Sound Spatialization (Mono, Stereo, Spatial), Auralization (no sound reflections, reflections corresponding to a room larger than the one perceived, reflections that exactly matched the virtual room), and Environment (no sound from outside of the

116 Slater, Mel et al.: "The Sentiment of a Virtual Rock Concert," *Virtual Reality* 27 (2023), pp. 651-675, here p. 652.

117 Mel Slater refers here to a concept taken from O'Regan, Kevin J./Noë, Alva: "A Sensorimotor Account of Vision and Visual Consciousness," *Behavioral and Brain Sciences* 24, no. 5 (2001), pp. 939-1031, here p. 939; O'Regan, Kevin J./Noë, Alva: "What it is like to see: A Sensorimotor Theory of Perceptual Experience," *Synthese* 129 (2001), pp. 79-103, here p. 79.

118 M. Slater et al.: "The Sentiment of a Virtual Rock Concert," p. 652.

room, birdsong and wind corresponding to the outside scene)" influence the "level of plausibility."[119]

Whereas spatialization turned out to be "less important for Psi" and auralization influenced plausibility by adding "to the sense of reality of the situation," the researchers found "that to deliver the illusion that the events were really happening participants tended to choose as most important two features […] the gaze directions of the players following the participants, and sounds from outside the room."[120]

While we have implemented the audio-related findings into our spatial sound design (to be discussed in section "7.2. Plausibility and Place Illusion"), especially the study's conclusions regarding the importance of gaze directions caused our focus on the bartender's eye movements being directed toward the nearest user.

Still, a newer study inspired our approach to animating our bartender even more. In this study, Mel Slater and his colleagues "created a virtual reality version of a 1983 performance by Dire Straits" to research "the concept of Plausibility."[121] The most interesting insights for our QUANTUM BAR use case were linked to feelings "classified as 'disturbing'."[122] The researchers observed that

"some participants felt vulnerable, and alone amongst the audience, had a feeling of being stared at by audience members (even though this was not programmed to occur) [which] signified a high degree of Plausibility of the experience, since a prerequisite of feeling disturbed is that the events in question must be experienced as really happening."[123]

Regarding the development of our bartender's gaze behavior, this insight validated Guillermo Valle-Pérez's original approach of implementing random glances in different directions while, in general, maintaining the bartender's gaze directed towards the nearest user (as described in section "5.1. Technical Setup").

According to Mel Slater and his colleagues, "a second contributor to lower sentiment scores was a failure of expectations—examples being the band not interacting with the audience, or the drummer not visually beating in time to the

119 Bergström, Ilias et al.: "The Plausibility of a String Quartet Performance in Virtual Reality," *IEEE Transactions on Visualization and Computer Graphics* 23, no. 4 (2017), pp. 1352-59, here pp. 1352-53.

120 Ibid., pp.1356-1357.

121 M. Slater et al.: "The Sentiment of a Virtual Rock Concert," p. 651.

122 Ibid., p. 653.

123 Ibid.

sound of the drums."[124] This finding motivated us to put much effort into the recording and playback of our bartender's idle and talking animations (as described in section "5.1. Technical Setup").

6 LOCALIZATION: BUILDING A VIRTUAL ENVIRONMENT FOR THE CHATBOT

The visual design of the QUANTUM BAR has been my effort. After I had decided for our GPT-3-driven chatbot to be a bartender with no long-term memory regarding his customers (as discussed in section "3.1. The ELIZA Effect"), I needed to design a bar for him as a workplace. Instead of opting for a realistic bar, I chose to situate our QUANTUM BAR in an oversized quantum computer floating in space (see Figure 11). I made this choice due to personal and scientific reasons, which I will discuss in the following.

Figure 11: Quantum Computer in Space

Source: Christina XaosPrincess Kinne

124 Ibid.

6.1 Virtual Reality as Mental Health Benefit

On a personal mental health level, during the lockdowns of the COVID-19 pandemic, it had been an enormous relief for me to spend time in open spaces simulated by virtual reality while I was bound to our indoor apartment. A similar effect could be observed in 2021 when a VR system proved to be "a substantial benefit to those who suffer from anxiety and claustrophobia"[125] in an MRI scanner. Thus—to counteract claustrophobic feelings[126]—I chose the fantastical open space environment as the location for our QUANTUM BAR.

6.2 Plausibility

In their study, Mel Slater and his colleagues defined a crucial requirement for plausibility "that where the VR depicts events or a situation that participants are quite familiar with in reality […] their expectations are met," arguing that "participants might well accept a VR with strange creatures or where normal physical laws are not obeyed […] but not accept a situation where some detail fails to meet expectations."[127]

Regarding the creation of a bar in the NEOS METAVERSE, I had two main concerns about not being able to meet the users' expectations. To guarantee a satisfactory performance on an end-user computer, I needed to optimize the experience by carefully choosing what 3D assets to implement while reducing their triangle count and draw calls to the minimum possible amount. This optimization approach made a realistic bar with all its furniture displayed in a photorealistic way impossible. Furthermore, the NEOS METAVERSE does not support physics yet, so objects would float in the air when released by a user.

Relying on Mel Slater's observation about the acceptance of imaginary worlds and non-realistic physical laws, I thus chose the strange but beautiful quantum computer as the location for our bar and outfitted it with the least amount of props that would still classify the construction as a bar, while banking on its location in space to explain the floating objects.

125 Qian, Kun et al.: "An Eye Tracking Based Virtual Reality System for Use inside Magnetic Resonance Imaging Systems," *Scientific Reports* 11, no. 1 (2021), pp. 1-17, here p. 14.

126 Cf. Chaturvedi, Rachna et al.: "Do Home Quarantine Individuals Suffer from Claustrophobia and Anxiety during COVID-19 Pandemic?" *Cogent Psychology* 9, no. 1 (2022), pp. 1-13, here pp. 9-10.

127 M. Slater et al.: "The Sentiment of a Virtual Rock Concert," p. 652.

6.3 Immersion according to Janet Murray

Different from Maria Sanchez-Vives's and Mel Slater's definition of immersion, which relies more on technical aspects like the field of view, rendering quality, frame rate, and latency,[128] Janet Murray describes immersion in a more human-centered way as "the sensation of being surrounded by a completely other reality" that is enjoyable to explore as "the delight [...] comes from learning to move within it."[129]

While designing the QUANTUM BAR's immersive environment, I took inspiration from Murray's insights on immersion in her pioneering book *Hamlet on the Holodeck.*[130]

6.3.1 Entering the Enchanted Place

Murray explains that "the computer itself […] is an enchanted object" that can "give us uninhibited access to emotions, thoughts, and behaviors that are closed to us in real life."[131] She argues that "immersion requires consistency and detail, and most of all a careful regulation of the boundary between the imaginary and the real."[132]

With these recommendations in mind, I decided against placing the users directly in the bar upon arrival and located their spawn point on a platform with a bridge leading to the quantum computer (see Figure 12). This design not only facilitates a smooth transition from the real to the imaginary world but also allows users to learn to move in the virtual environment delightfully.

As I needed to explain which buttons of various controllers should be pressed to trigger certain functions in the NEOS METAVERSE, I took Murray's insight about learning quite literally and installed an interactive question mark that would disclose a three-dimensional controls explanation when being triggered. I used the same approach to meet the challenge of copyright display by installing a triggerable credits board (see Figure 12).

For educative installations of the QUANTUM BAR, I plan to use the perimeter of the arrival platform to display explanations of GPT-3's functionality as well as on AI and VR technology and ethics.

128 Cf. M. Sanchez-Vives/M. Slater: "From Presence Towards Consciousness," p. 4.

129 Murray, Janet H.: *Hamlet on the Holodeck*, New York, NY: Simon and Schuster 2016, p. 99.

130 Ibid.

131 Ibid.

132 Ibid., p. 120.

Figure 12: Arrival Platform with Controls Explanation and Credits Board

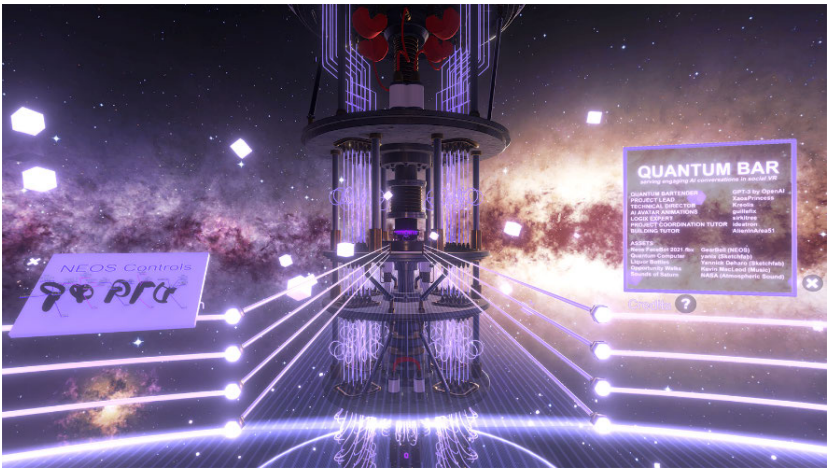


Figure 13: Interactive Objects from the NEOS METAVERSE Stock

Source: Christina XaosPrincess Kinne

6.3.2 The Active Creation of Belief

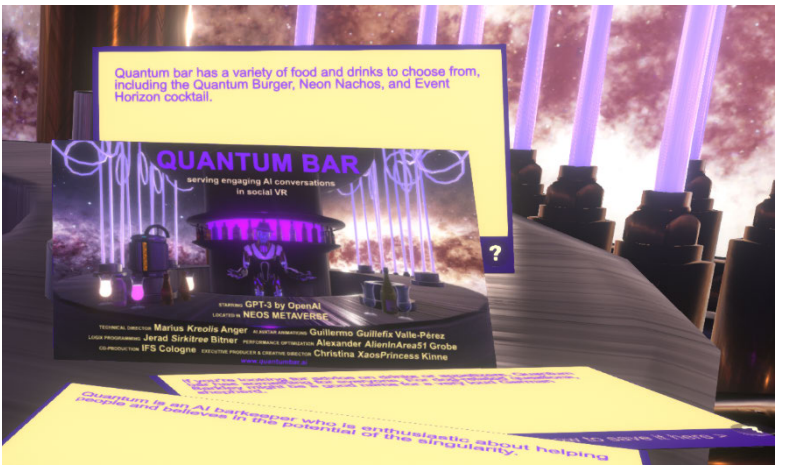
"When we enter a fictional world," explains Murray, "we do not merely suspend disbelief so much as we actively create belief." She calls for actions and adventures in a virtual environment as a visit "loses its immersive hold [if] nothing is

happening there."[133] While the main adventure in the QUANTUM BAR is, of course, the conversation with our GPT-3-driven bartender, I also placed interactive bottles and glasses on the bar counter (see Figure 13), as, according to Murray "the experience of using objects and seeing them work as they are supposed to in our hands creates the feeling of being a part of [a virtual] world."[134]

6.3.3 Finding the Border

Janet Murray also repeatedly emphasizes the importance of "the exploration of the border between the representational world and the actual world"[135] and points out how "an entrance and an exit [...] mark the beginning and end of [a] story."[136]

Figure 14: Summary Card



Source: Christina XaosPrincess Kinne

While it was an easy task to design an appropriate entrance for our QUANTUM BAR (as discussed in section "6.3.1. Entering the Enchanted Place"), defining an end of the experience was more challenging since it is usually up to the social VR users to decide how long they want to stay in the immersive environment. To mark an enriching end of our experience, I took inspiration from Joseph Campbell's *The*

133 Ibid., p. 107.

134 Ibid., p. 109.

135 Ibid., p. 102.

136 Ibid., p. 105.

Hero With A Thousand Faces and decided to issue a reward.[137] Our bartender, therefore, ends the conversation by gifting the user a card (see Figure 14) that displays a summary of their chat compiled by GPT-3.[138] In our present version, this card can be saved to the NEOS METAVERSE inventory. For future iterations, we plan on sending it to social VR users via email. For festival visitors, we currently print out a hard copy on location.

7 AURALIZATION: GIVING THE CHATBOT A VOICE AND ADDING SOUNDS TO THE ENVIRONMENT

For similar optimization reasons as mentioned in section "6.2. Plausibility," we decided to implement as few audio sources as possible while still enforcing place illusion and plausibility in the QUANTUM BAR. We gave our bartender the US English male voice *David*,[139] and complemented the space environment with NASA's "Spooky Sounds from Saturn"[140] while we chose Kevin MacLeod's jazz track "Opportunity Walks"[141] for the QUANTUM BAR's music. Furthermore, we added sound effects provided by the NEOS METAVERSE to functional objects like buttons or portals.

In the following, I will elaborate on the research supporting our choices in sound design.

7.1 The Uncanny Valley Effect in Speech Fidelity

My choice to give our bartender a WINDOWS system voice originated from cost-efficiency (the text-to-speech generation can be executed free of additional costs on a personal computer). A study from 2022 validated my decision. The study compared standard text-to-speech (TTS) systems to "Neural TTS […] a relatively

137 Cf. Campbell, Joseph: *The Hero with a Thousand Faces: Commemorative Edition*, Princeton, NJ: Princeton University Press 2004, p. 227.

138 Cf. OpenAI: "Examples—TL;DR Summarization," https://platform.openai.com/examples/default-tldr-summary

139 Cf. Microsoft: "Download Languages and Voices."

140 NASA: "Spooky Sounds from Saturn," https://solarsystem.nasa.gov/resources/17359/spooky-sounds-from-saturn/

141 Incompetech, Inc.: "Opportunity Walks Kevin MacLeod," Royalty Free Music, January 1, 2006, https://incompetech.com/music/royalty-free/index.html?isrc=USUAN1100123&Search=Search

recent advancement that mimics human speech more accurately […] by utilizing long-short term (LSTM) neural networks that are conditioned on previous utterances"[142] and yielded unexpected results:

"Our findings indicate that Neural TTS may not be a favorable choice for a virtual human's speech. With respect to perception ratings, Neural TTS may actually be more unfavorable than Standard TTS, if we consider the Human speech condition as a 'gold standard'[143] of quality […] These results indicate that Standard TTS may be sufficient for applications. In this case, developers would not have to pay four times as much for neural TTS[144] or hire voice actors, which may slow down development or incur more costs."[145]

The researchers "found that the virtual human with Human speech was rated as significantly more *Trustworthy* than one with Neural TTS, but there was no significant difference between Human speech and Standard TTS"[146] and postulate that this effect might be due to an auditory uncanny valley effect, as "the Neural TTS condition may have produced experiences similar to human speech, except for key infections and pauses within the speech synthesis [while] the decreased mental load of Neural TTS may have allowed users to analyze specific qualities of speech."[147]

142 Do, Tiffany D./McMahan, Ryan P./Wisniewski, Pamela J.: "A New Uncanny Valley? The Effects of Speech Fidelity and Human Listener Gender on Social Perceptions of a Virtual-Human Speaker," *CHI Conference on Human Factors in Computing Systems* 22, no. 424 (2022), pp. 1-11, here p. 1.

143 Tiffany Do refers here to a research paper by Dubiel, Mateusz et al.: "Persuasive Synthetic Speech: Voice Perception and User Behaviour," *Proceedings of the 2nd Conference on Conversational User Interfaces* (2020), pp. 1-9, here p. 3.

144 To illustrate the price disparity between standard and neural TTS, Do refers to Amazon: "Amazon Polly Pricing," https://aws.amazon.com/polly/pricing/; Microsoft: "Cognitive Services Pricing," https://azure.microsoft.com/en-us/pricing/details/cognitive-services/speech-services/

145 T. Do et al.: "A New Uncanny Valley?" p.8.

146 Ibid., p. 6.

147 Ibid., p.7.

7.2 Plausibility and Place Illusion

As mentioned in section "5.2. Plausibility," environment and gaze are crucial factors for plausibility.[148] Particularly relevant for credible illusions are "sounds from outside the room."[149] We, therefore, implemented the radio waves from Saturn as atmospheric sound to enhance the plausibility of the space environment that encompasses our QUANTUM BAR. To further accentuate the environment of a bar, we located a spatialized jazz loop in the column behind our bartender. As spatialization was found to be essential for place illusion, helping "to locate the participant with respect to the environment,"[150] we spatialized not only the bar music but also our most important sound asset—our bartender's voice.

The fourth examined feature was auralization which, in the study (as opposed to this section's title), refers to sound reflections.[151] Since it "does not correspond to a sensorimotor contingency,"[152] auralization proved to be not important for place illusion and was also described to be less important for plausibility.[153] In the QUANTUM BAR, we did not implement any sound reflections for two more reasons: Reverb zones are currently not supported in the NEOS METAVERSE, and in our open space, there is also no enclosed room that could motivate sound reflections.

The study on "The Sentiment of a Virtual Rock Concert" observed that to generate "strong PSi [...] meeting expectations is essential." As an example, it gives "the technical capability to match up movements of virtual characters (such as clapping) with the corresponding sounds."[154] As our bartender's animations are played back randomly (as discussed in section "5.1. Technical Setup"), the idea of matching his movements with a repetitive rhythm of a musical piece posed a challenge, which is why we chose a jazz track whose shuffle beat is more forgiving to our—at times erratic—animations.

148 Cf. I. Bergström et al.: "The Plausibility of a String Quartet Performance in Virtual Reality," p. 1352.

149 Ibid., p. 1357.

150 Ibid., p. 1356.

151 Cf. ibid., p. 1352.

152 Ibid., p. 1356.

153 Cf. ibid., p. 1352.

154 M. Slater et al.: "The Sentiment of a Virtual Rock Concert," p. 670.

8 ILLUMINATION: LIGHT DESIGN IN THE VIRTUAL ENVIRONMENT

Due to performance reasons, we chose to add no more than three light sources to our virtual environment (see Figure. 11). With its origin at the angle of the sun glow depicted in the skybox, the main light is directed from behind the bartender. A second, less bright, directional light source originating from the arrival perimeter is used as fill. The third light is located on top of the bar counter. Its color is steered by GPT-3's sentiment detection.[155]

Figure 15: Light Design

Source: Christina XaosPrincess Kinne

If a user's dialogue line has been classified as 'negative,' this point light will turn purple, while a 'positive' sentiment will make it glow magenta. The same steering function is used on the emissive materials of our 'talking spot' on the floor and

155 Cf. OpenAI: "Examples—Advanced Tweet Classifier," https://platform.openai.com/examples/default-adv-tweet-classifier

the column behind the bottles (see Figure 15). While we initially implemented this light steering mechanism as a proof of concept for our ability to display sentiment detection, it now adds to the atmosphere and the plausibility of the QUANTUM BAR experience.

In the following, I will discuss further research on plausibility that inspired my light design.

8.1 Plausibility

Insu Yu and his colleagues have observed that "dynamically changing shadows and reflections in response to body movements [and] global illumination" are important factors for achieving plausibility in a virtual environment.[156] Following their study's concluding recommendation that describes "real-time global illumination with dynamic changes to reflections and shadows as worth the effort,"[157] we added the functionality of dynamic shadows for objects and avatars to the main light and implemented the additional fill to mimic global illumination in the QUANTUM BAR's light design, even though these were two of our 'most expensive' features in terms of performance efficiency.

9 USER OBSERVATIONS

Up to now, we have opened the QUANTUM BAR on invitation for social VR users (see Figure 16) and publicly for my graduation ceremony at the ifs Internationale Filmschule Köln[158] as well as for our world premiere at VRDays Immersive Tech Week Rotterdam.[159] Furthermore, we showcased the QUANTUM BAR at various

156 Yu, Insu et al.: "Visual Realism Enhances Realistic Response in an Immersive Virtual Environment--Part 2," *IEEE Computer Graphics and Applications* 32, no. 6 (2012), pp. 36-45, here p. 45.

157 Ibid.

158 Cf. ifs Internationale Filmschule Köln: "Final Presentation MA Digital Narratives 2022," https://www.filmschule.de/de/aktuelles/news/final-presentation-ma-digital-narratives-2022

159 VRDays—Immersive Tech Week 2022: "Church of VR," https://vrdays.co/church-of-vr/

international festivals like Laval Virtual in Laval, France,[160] the 4GAME-CHANGERS Festival in Vienna,[161] and the Munich Festival of the Future.[162]

Figure 16: Social VR Users visiting the QUANTUM BAR

Source: Christina XaosPrincess Kinne

9.1 Social VR

While I have been happy to observe that users of all experience levels enjoyed staying in VR for more than 15 minutes to talk to our AI bartender, two learnings from our social VR deployments led to new implementations in our development.

Group visits revealed a pleasant social impact as joined conversations with our bartender led to bonding among the group members. Still, this effect also illustrated a technical challenge when conversations were happening simultaneously. As our speech-to-text system picked up on anything being said, the prompts became very confusing, and GPT-3 had justified trouble keeping up with incoherent statements like a question regarding the singularity in the actual conversation

160 Laval Virtual: "2023 ReVolution," https://laval-virtual.com/en/2023-revolution/

161 ProSiebenSat.1 PULS 4 GmbH: "4GAMECHANGERS FESTIVAL 2023," https://4gamechangers.io/en/a/festival/

162 1E9 Denkfabrik GmbH: "IE9—Festival of the Future 2023," https://festivalderzukunft. com/EN

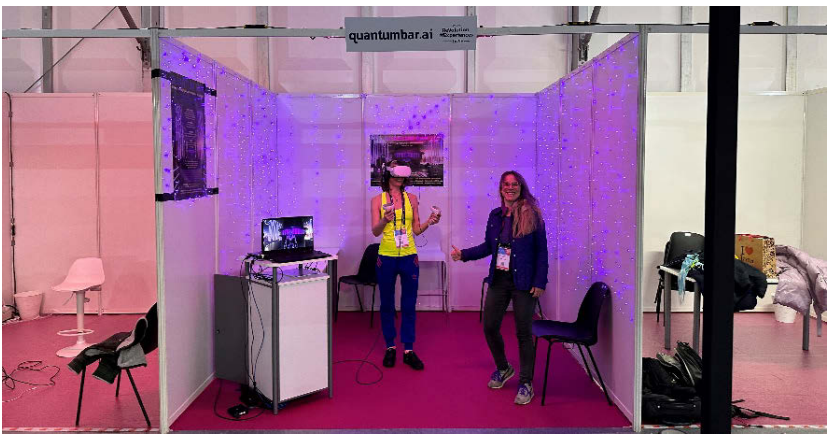
overshadowed by a discussion on haircutting on the side of the bar. This observation inspired us to link the various users to different audio zones so that our speech-to-text system would only receive the voices from users standing on the 'talking spot' in front of the bar.

During our presentations, we also realized that the user interface of the NEOS METAVERSE was often confusing for visitors new to the platform, which made saving our summary card sometimes a complicated experience. For further deployments of the QUANTUM BAR, we have thus implemented a solution that prints out a hard copy for visitors on location. In the future, we plan on sending the summary card to social VR users via email.

9.2 Festival Installations

Our festival installations (see Figure 17) also yielded rewarding results. While our industry showcases at VRDays Immersive Tech Week and Laval Virtual provided us with inspiring professional discussions and promising collaboration opportunities, it were especially the events that were open to a more general public—4GAMECHANGERS and the Festival of the Future—which lead to the most interesting insights.

Figure 17: QUANTUM BAR Booth at Laval Virtual



Source: Christina XaosPrincess Kinne

Children and teenagers between the ages of seven and fourteen turned out to be the most proficient VR users. Even though many had never been in VR before, they instantly understood all functions and intuitively indulged in activities—like

climbing or sword fighting—whose execution I never explained in my onboarding presentations. Another surprise that accounted for children and adults alike was the fascination with social VR. As soon as a user realized that another user joined them from the second user station we provided, their focus shifted away from the bartender to the delight of being able to interact with another human in VR.

10 DISCUSSION AND OUTLOOK

10.1 Research

While the above-discussed visits to the QUANTUM BAR yielded rewarding insights, illustrating that our research-based creation process did not bear any significant setbacks, these user observations can only be seen as spot checks. To investigate if the QUANTUM BAR experience performs well in all psychological and technological regards, I would need to have a more significant sample of users on a wider variety of end devices.

Given the opportunity, I would like to conduct more research-based user testing, focusing on the following areas of interest:

- ELIZA Effect
- Anthropomorphisation
- Uncanny Valley Effect
- Plausibility
- Place Illusion

Additionally, I would be happy to provide the QUANTUM BAR environment as an experimental setup for further research on prompt design and AI safety as well as on the psychological effects of virtual spaces and character creation.

10.2 Educational Platform

Reviewing my three-year journey of creating a GPT-3-driven chatbot for social VR and showcasing it to the public revealed two main insights that inspired me to the next iteration of the QUANTUM BAR.

On the one hand, I was as astounded as anybody else about the "Cambrian explosion"[163] of AI applications and use cases over the last few years. On the other hand, I was shocked to learn just how few of our technophile festival guests had been in social VR before resp. how sparse the practical Metaverse experience of the general public actually is.

Together with our technical director Marius Anger, I thus plotted the next big step on our roadmap: By integrating newer LLMs—like ChatGPT, GPT-4, or Google's Bard[164]—as additional bartenders and by implementing further AI applications—like 3D object generation via Point-E[165]—we plan to expand the QUANTUM BAR to an educational platform that will not only enable academics, students, and decision-makers to learn by experience about the technological and ethical implications of AI development but which will also facilitate an entry into the Metaverse and contribute to its mass adoption.

As of now, and even more so in the future, we would be overjoyed to welcome you, the reader, to our QUANTUM BAR. If you have access to PCVR, please follow the onboarding instructions[166] on our homepage to enter the Metaverse and have engaging AI conversations with our GPT-3-driven bartender and his creators.

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164 Google: "Bard," https://bard.google.com/

165 OpenAI: "Point-E," https://github.com/openai/point-e/blob/main/README.md

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