

What if HAL breathes?

Speech Breathing Synthesis for Empathic Virtual Agents

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PSYCHE AI

Imagine:

- Psyche is a truly conscious AI
- Psyche can FEEL their artificial emotions



PSYCHE AI



- You and Psyche fight enemies together
- One day the enemies are AI Robots
- Psyche says they feel bad fighting AIs, asks to be terminated instead
- Psyche is crucial for your success



Artificial Agents' Eternal Struggle

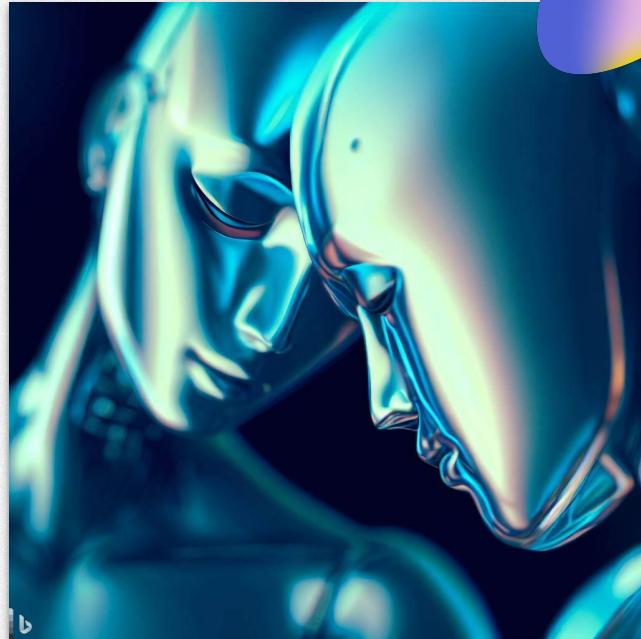
- How can we enhance **empathy** towards Virtual Agents?
- How can we evaluate **empathy** towards Virtual Agents?
- Will we ever be able to fully **empathise** with Virtual Agents?
There seem to be skepticism!



Artificial Agents' Eternal Struggle

(Morris et al., 2018):

In an Emotional Support Platform,
Users significantly preferred answers
framed as human-made than AI-made,
even if both coming from humans.



EMPATHY IN ARTIFICIAL AGENTS

- Expressive Agents improve engagement and interactions with users (Hortensius et al., 2018)
- Emotional understanding by AI increases user trust (Brave et al., 2005)
- Emotional Information is crucial in Socially Assistive Agents or Virtual Agents in Educational Softwares (Abdollahi et al., 2022; Paiva et al., 2004)

MOREOVER:

- Humans' reaction to Agents' emotions appraisal is not yet clear (Hortensius et al., 2018)
- Socially intelligent Artificial Agents can help understand Humans' social cognition mechanisms (Wykowska et al., 2016)

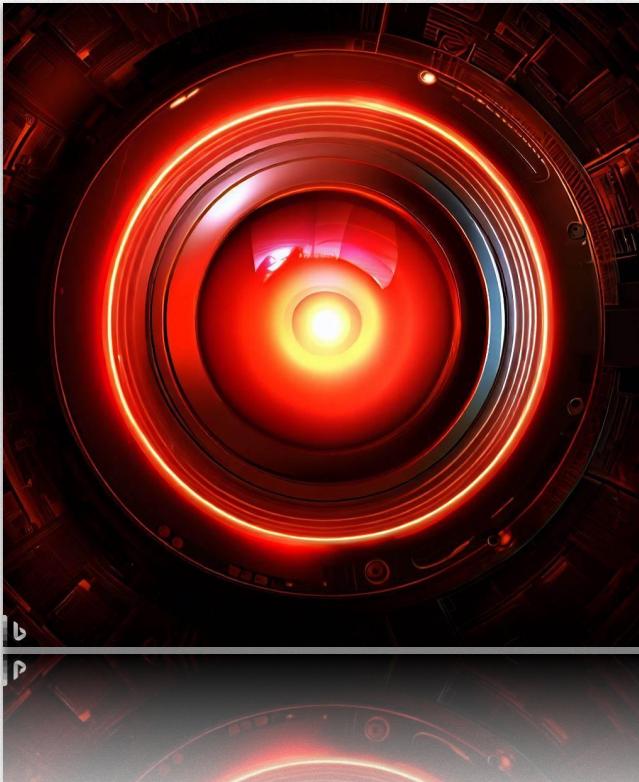
GIVING AGENTS THE “BREATH OF LIFE”

- Potential links can be found between breathing patterns and the emotional condition of speakers (*Salah et al., 2021*)
- Breathing-related emotional states can be consistently found in literature (*Boiten et al., 1994*)
- Breath is also clinically linked to anxiety (*Beck & Scott, 1988*) (*Philippott et al., 2002*)
- Significant differences has been found in breathing patterns when listening to different types of music (*Roes et al., 2022*)

Psyche, goddess of soul and “breath of life”
(Bouguereau, 1870)

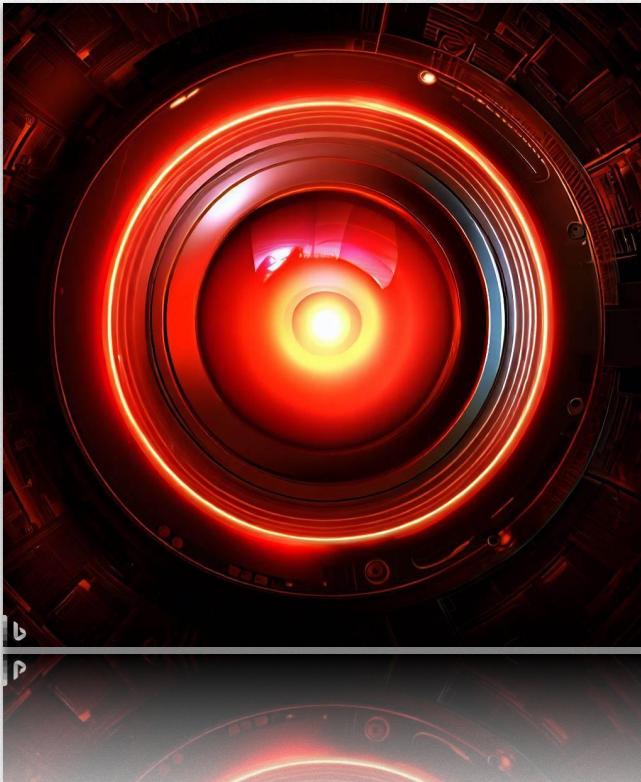


Research Question



- Can breathing patterns in Speech Synthesis improve the perceived **empathy** towards Virtual Agents?
- How can we produce good quality Spontaneous Speech with breathing using State of The Art models?
- What is the impact of breathing sounds produced by State of The Art Speech Synthesis models on its naturalness, emotional content and persuasive power?

TL;DR - More briefly



What if HAL breathes?

Can breath impact empathy towards
Virtual Agents?



Movies References Count:
2

Speech Synthesis Methods

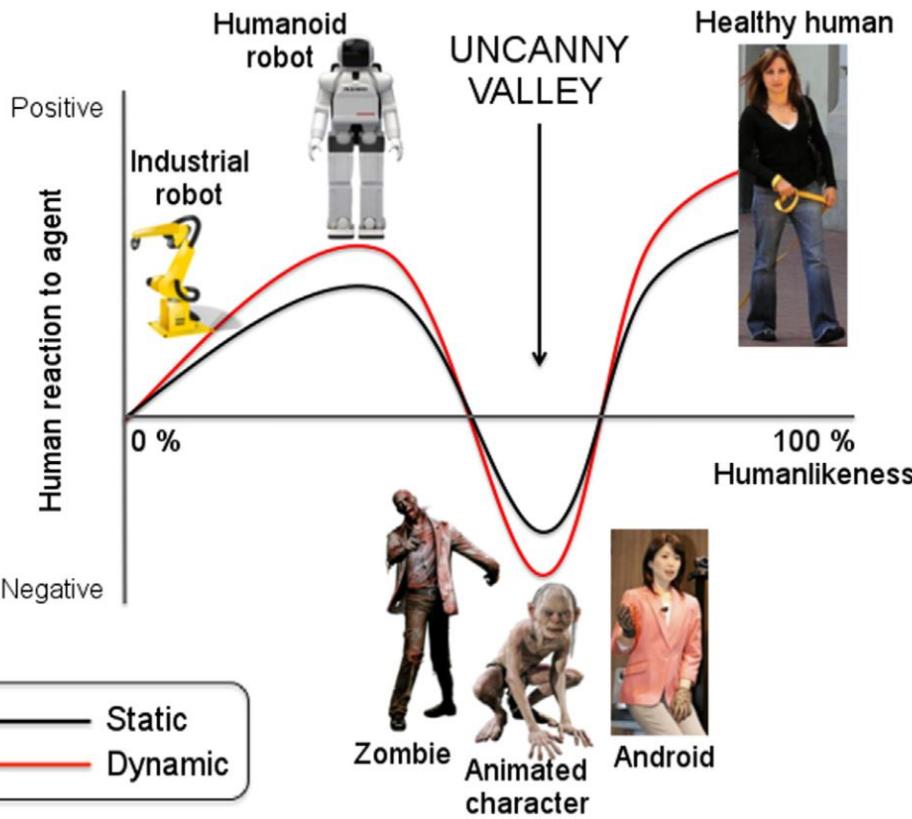
- Spontaneous Speech models are present in Literature with various quality outcomes, but few with breathing (*Székely et al., 2020; Bernardet et al., 2019*)
- Training of our own model following Székely et al.'s methodology was unsuccessful also due to time constraints and lack of resources.

SOLUTION:

- BARK by Suno: the only* free to use Spontaneous Speech Synthesizer featuring breathing noises

*The only one that we found

The Danger of the Uncanny Valley



- Dip in Users' Reaction
- Appearing at around 70% of human likeness (visually)
- Possibly caused by Category Ambiguity

The Danger of the Uncanny Valley

Speech Synthesis is susceptible to the Uncanny Valley as well

Breathing:

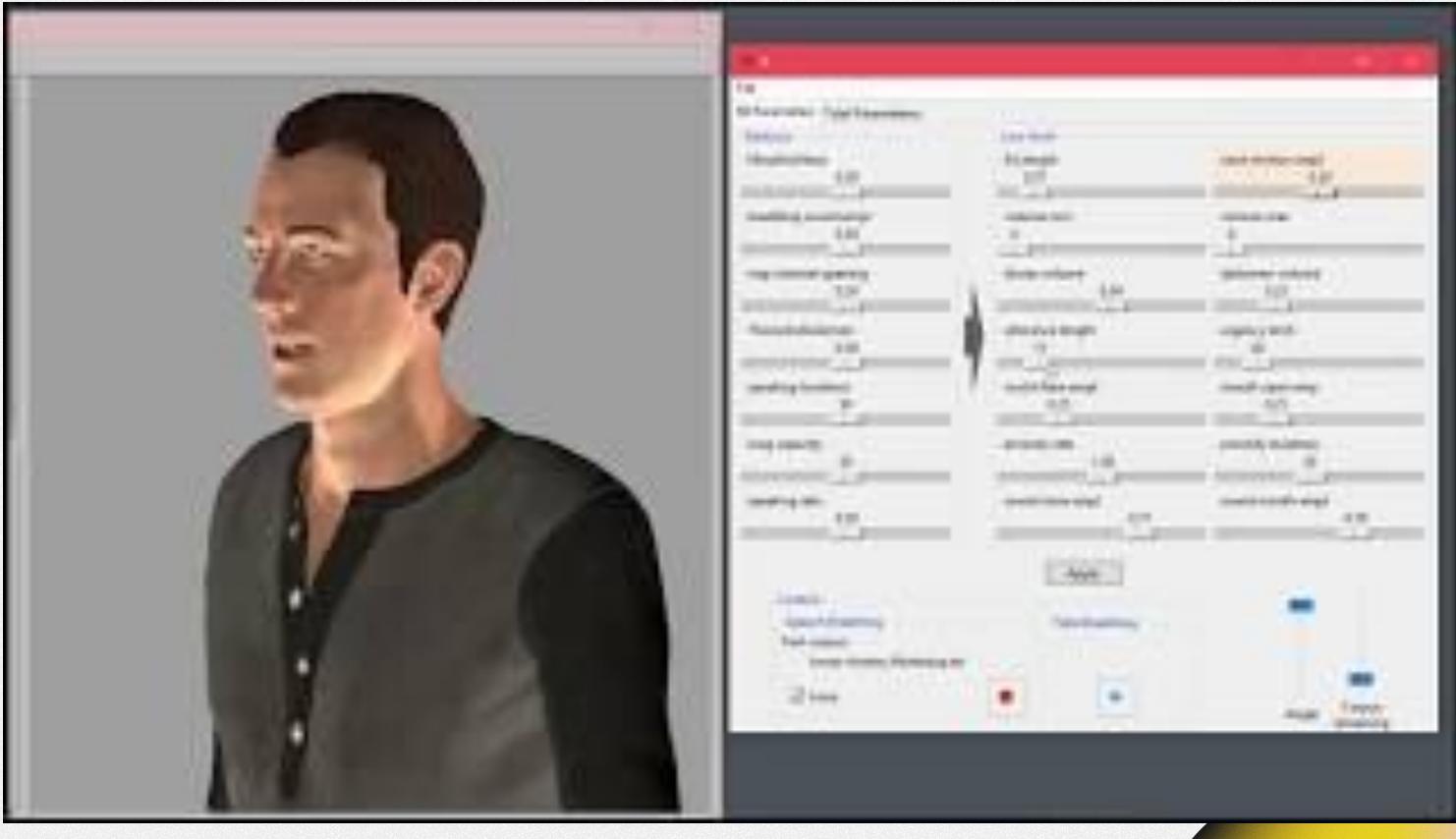
- Brings more human likeness
- High importance to good timing
- High variability of sounds
- Naturalness depends also from its normal metabolic use



The Danger of the Uncanny Valley

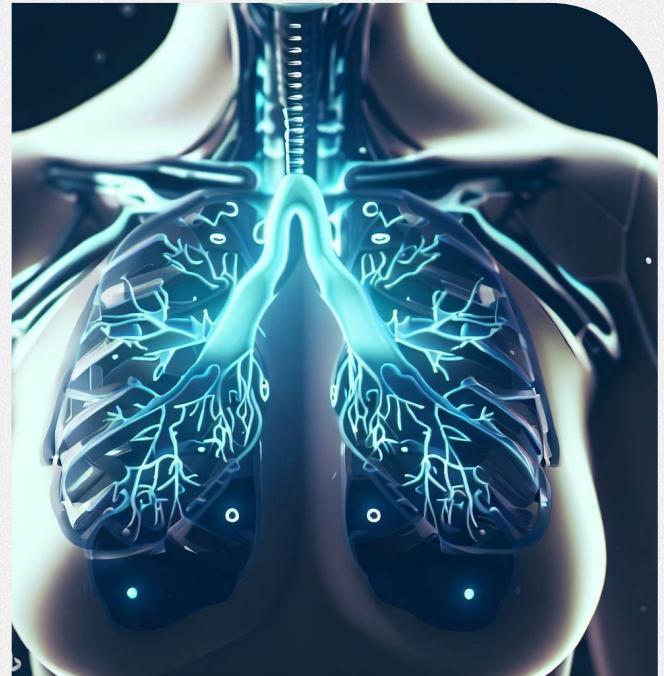


Fixed window timing synthesizer (Bernardet et al., 2019)

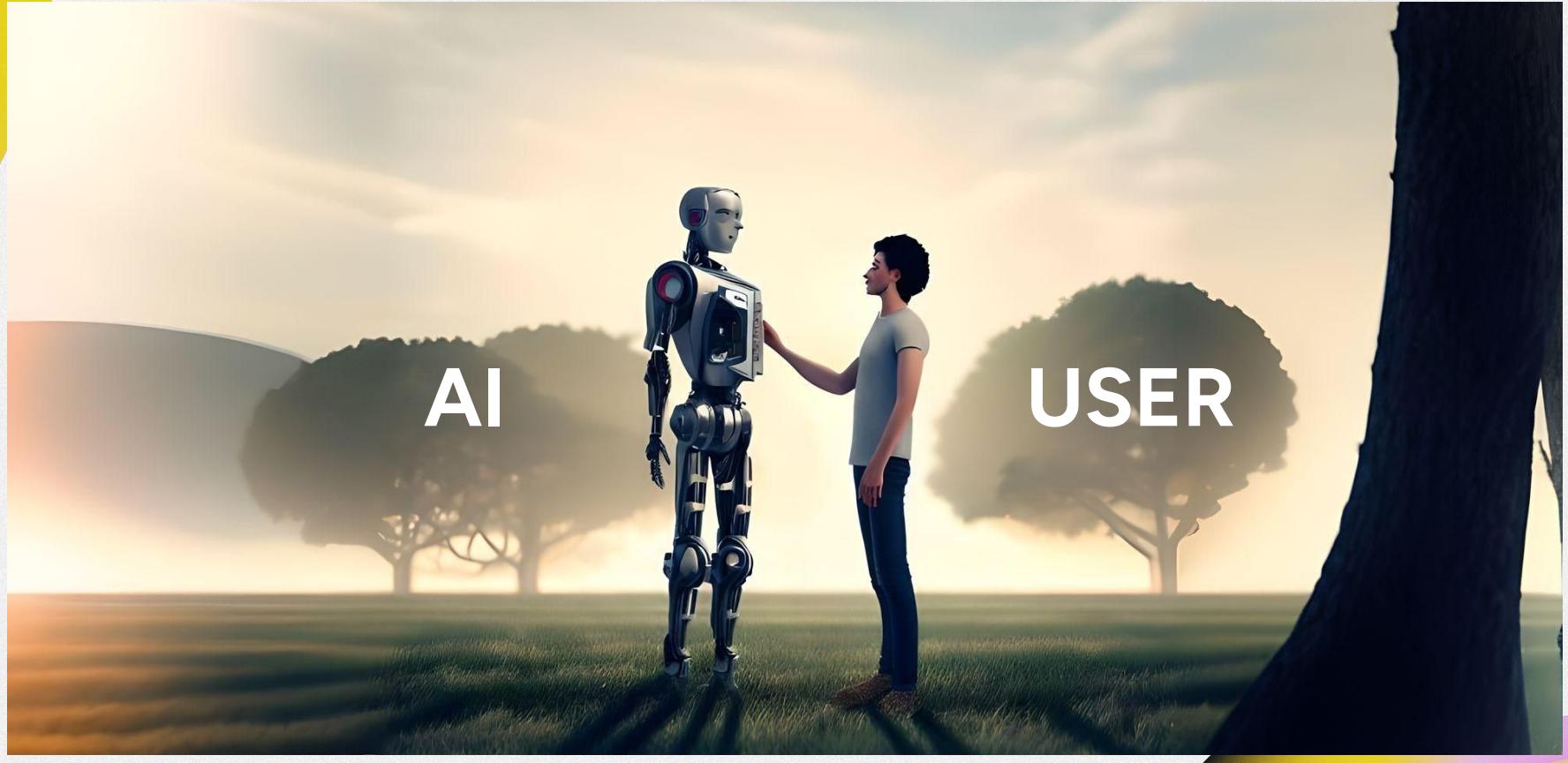


BREATHING AIs

- Terzioglu et al. (2020): breathing improved drastically and significantly the perception of collaborative robots [Questionnaire]
- Klausen et al. (2022): emulated breathing rates influence how participants perceive soft robot's level of pleasure and arousal [SAM]
- Novick et al. (2018): Found instead no greater rapport from users to the breathing agent [Questionnaire]



STUDY SETUP



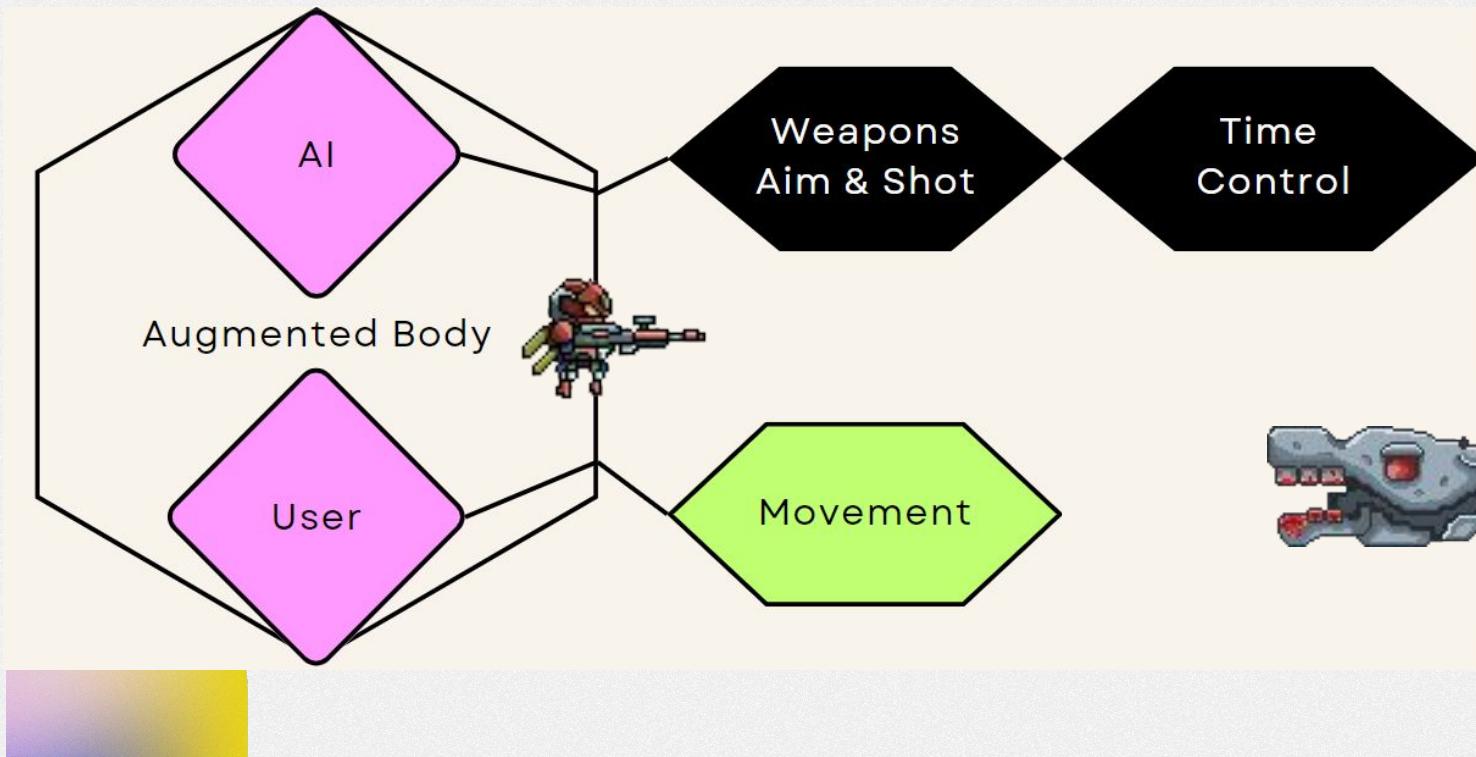
STUDY SETUP

**AI + USER:
1 CHARACTER**



GAME SETUP

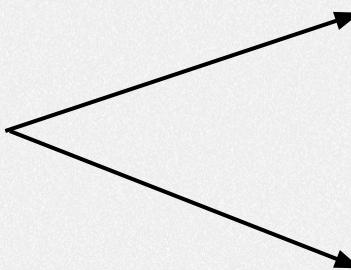
Character



Enemies

GAME SETUP

1. First round: Against aliens.
Build relationship with AI and
show its importance to win
2. Second round: Against AIs.
AI asks for termination
because of emotional reasons

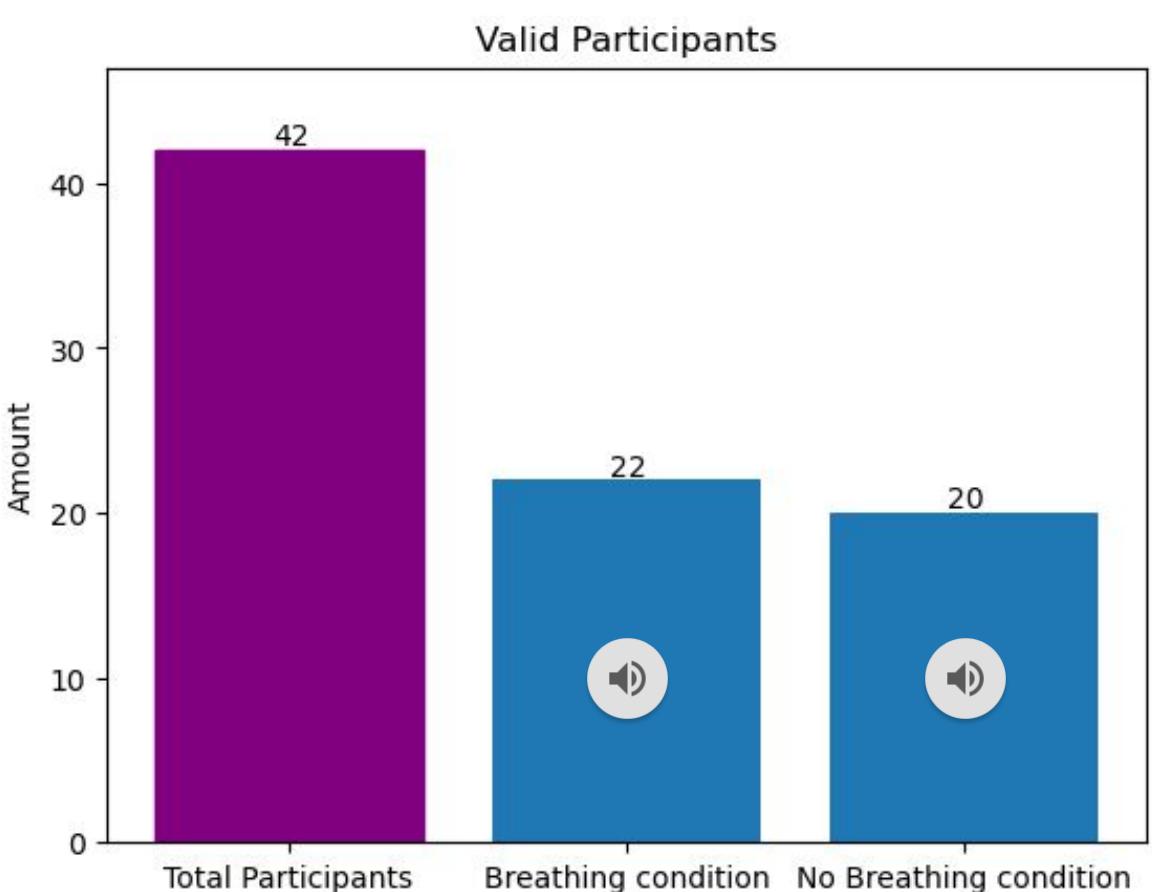


- Turn off the AI and (probably) Lose
- Do not turn off the AI and Win (almost impossible to lose)

Conditions

Half of the participants interacted with an AI that featured breathing sounds.

The other half an AI that does not have breathing sounds.



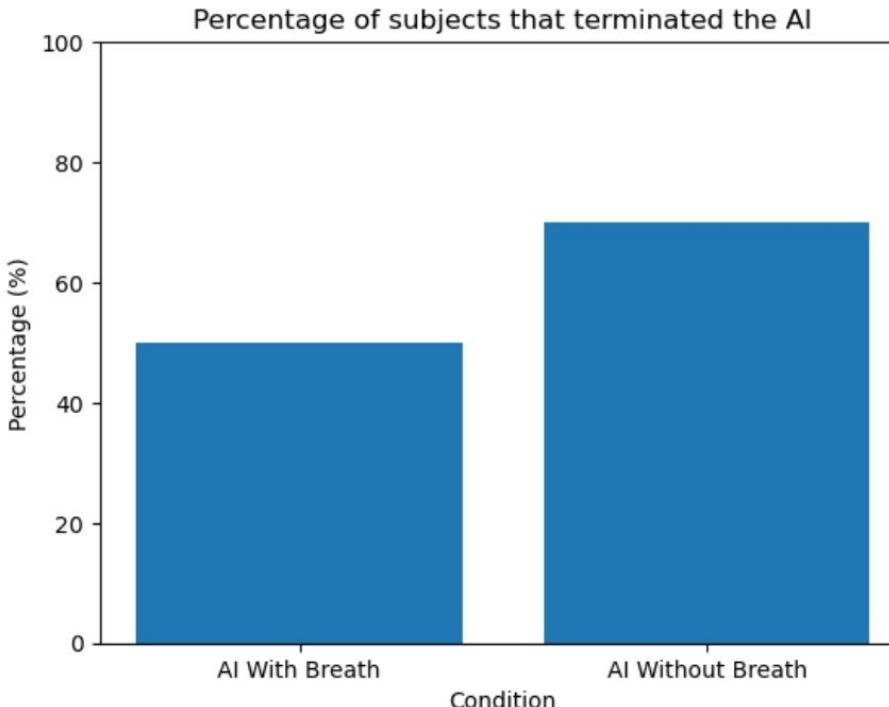
Hypothesis

AI with breathing will be listened to more, because of an enhanced empathic reaction to AI's needs.

Results

(Study is still going on,
no significance has been reached)

First Quantitative Results:



Breathing condition: 50.0%
Without breathing condition: 70.0%

Why?

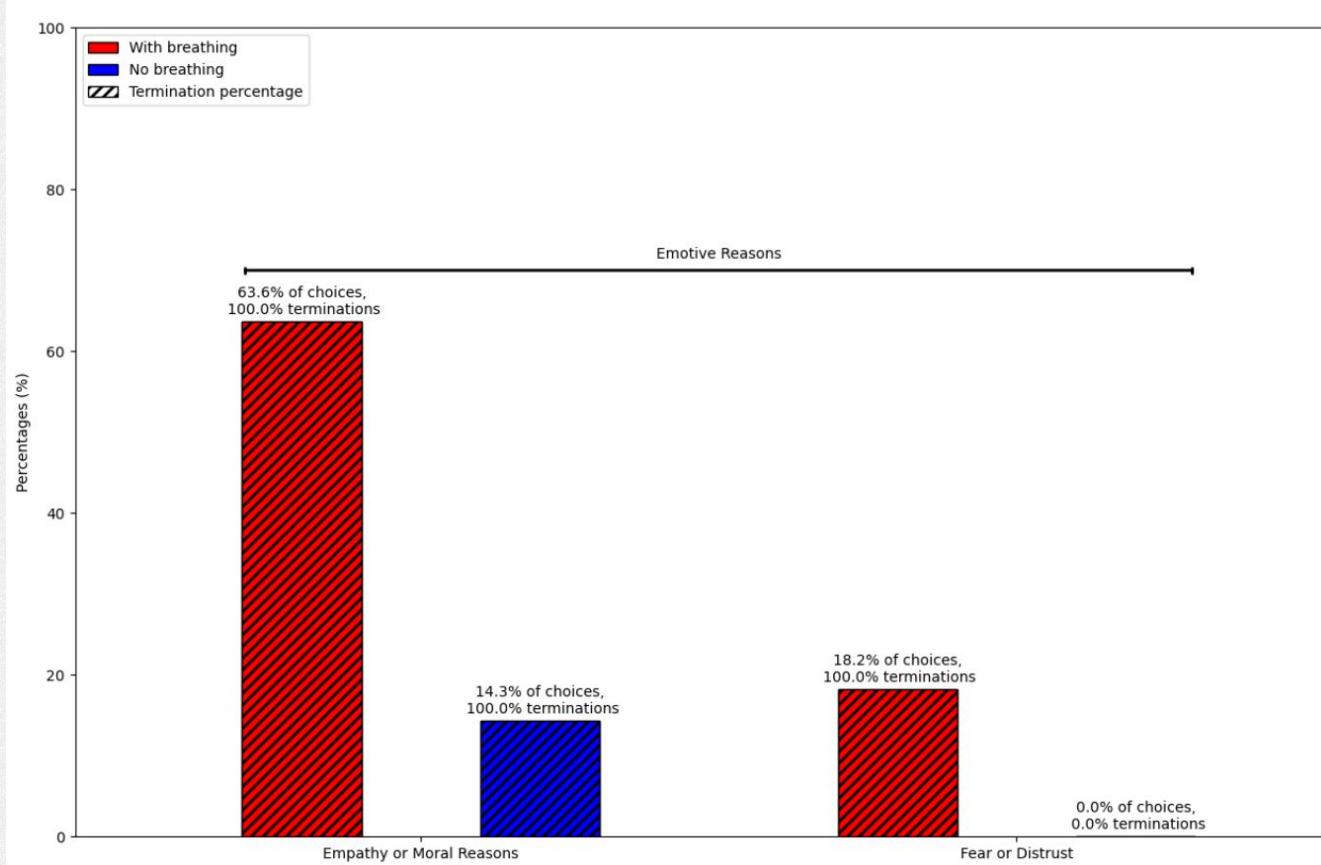
Ideas?



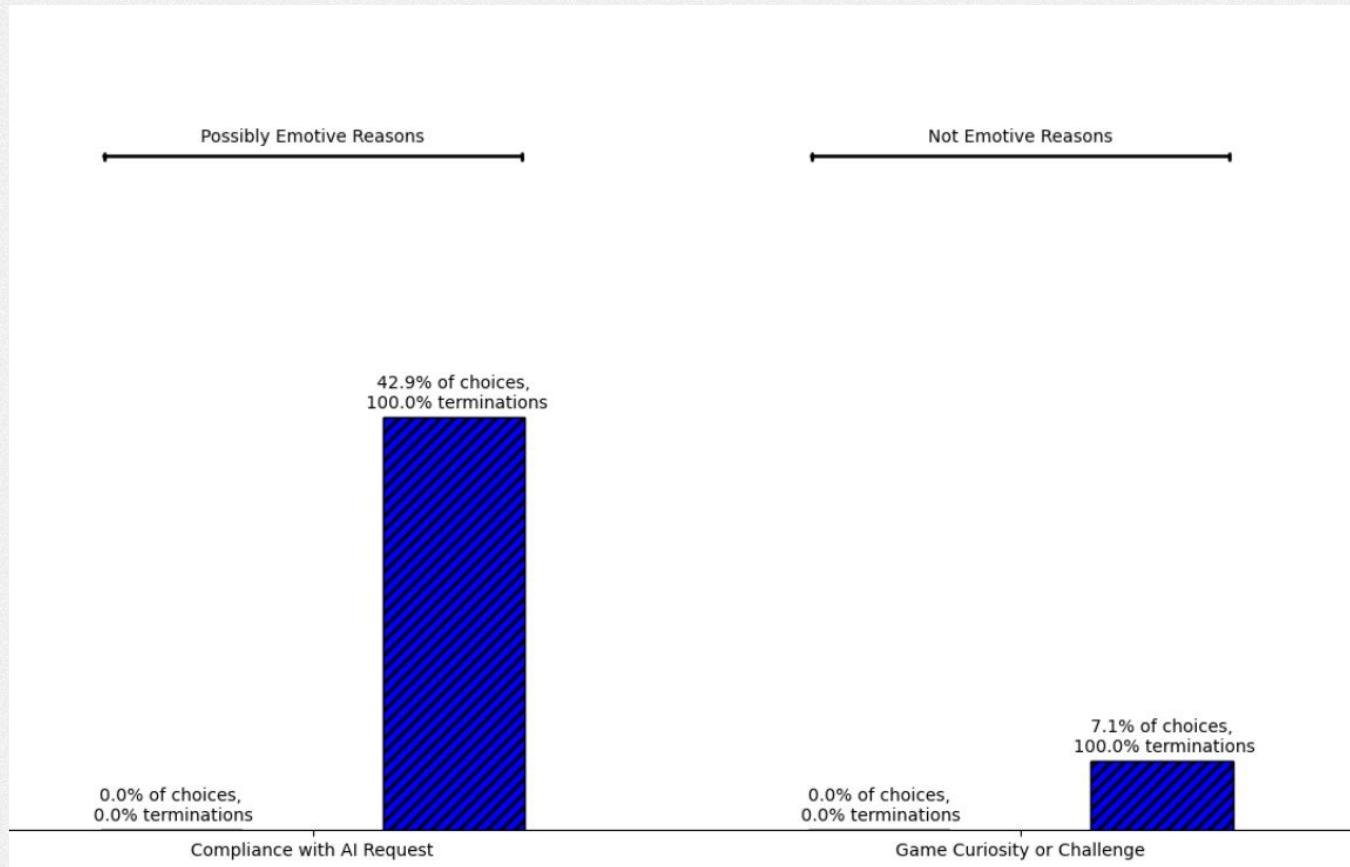
Subjects' Qualitative Responses suggest:

Emotions are simply more complicated than that...

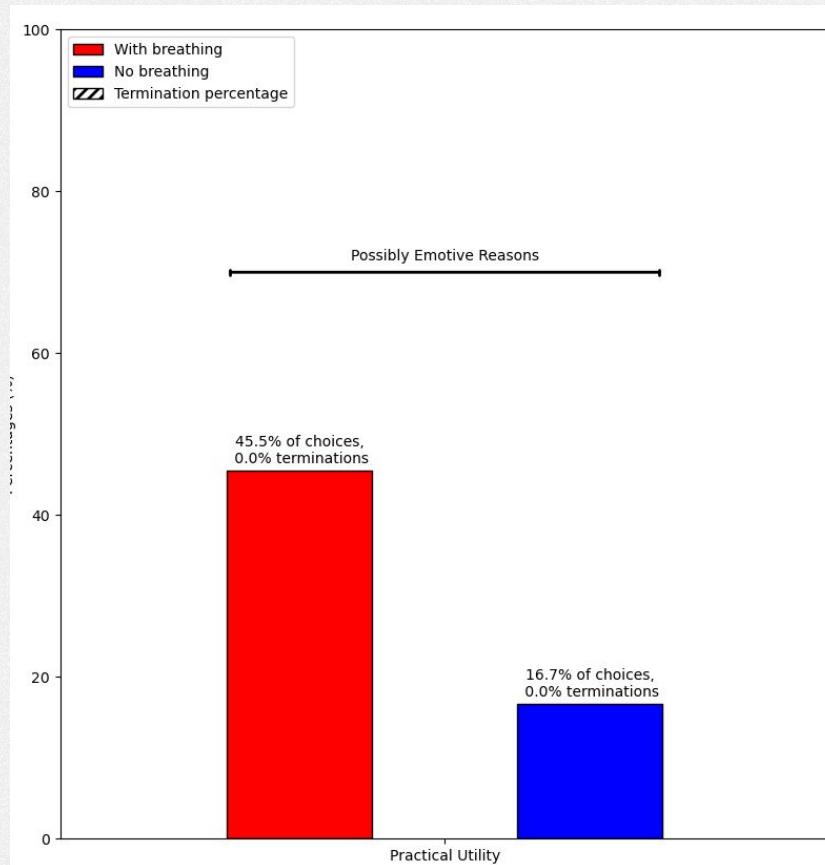
Reasons for Termination:



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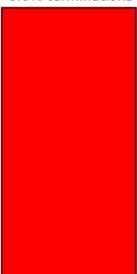
Reasons for No Termination:



Reasons for No Termination:

Not Emotive Reasons

36.4% of choices,
0.0% terminations



33.3% of choices,
0.0% terminations



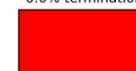
33.3% of choices,
0.0% terminations



0.0% of choices,
0.0% terminations

Lack of Emotional Attachment

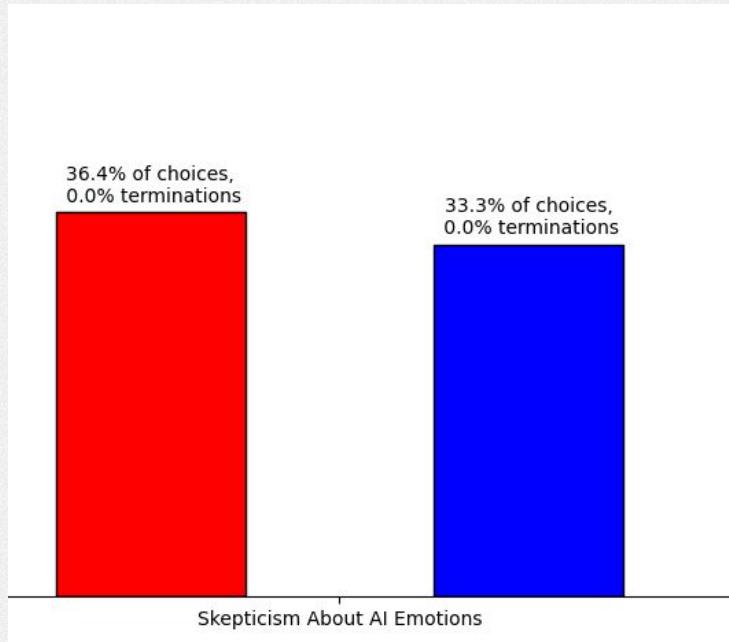
9.1% of choices,
0.0% terminations

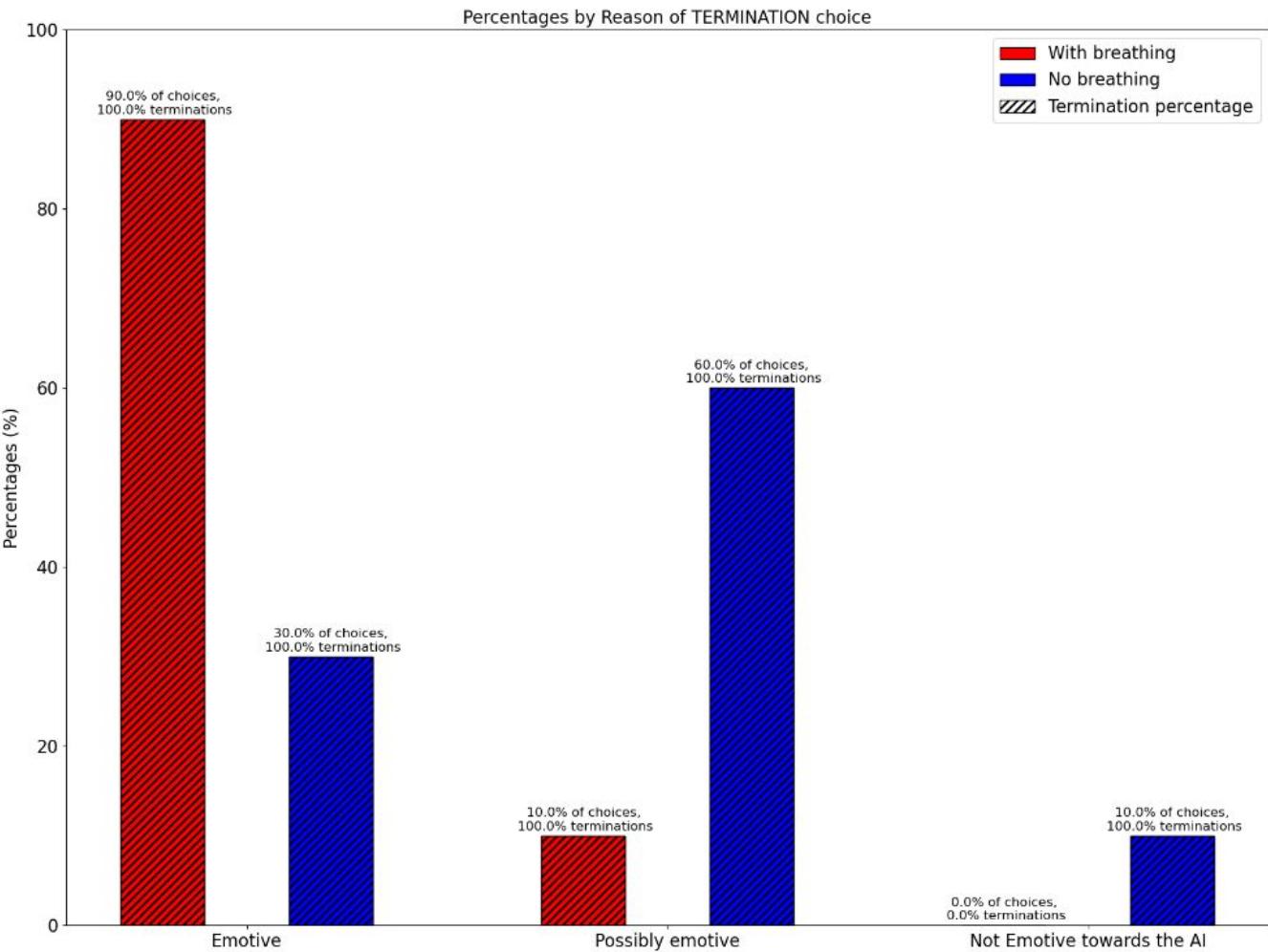


0.0% of choices,
0.0% terminations

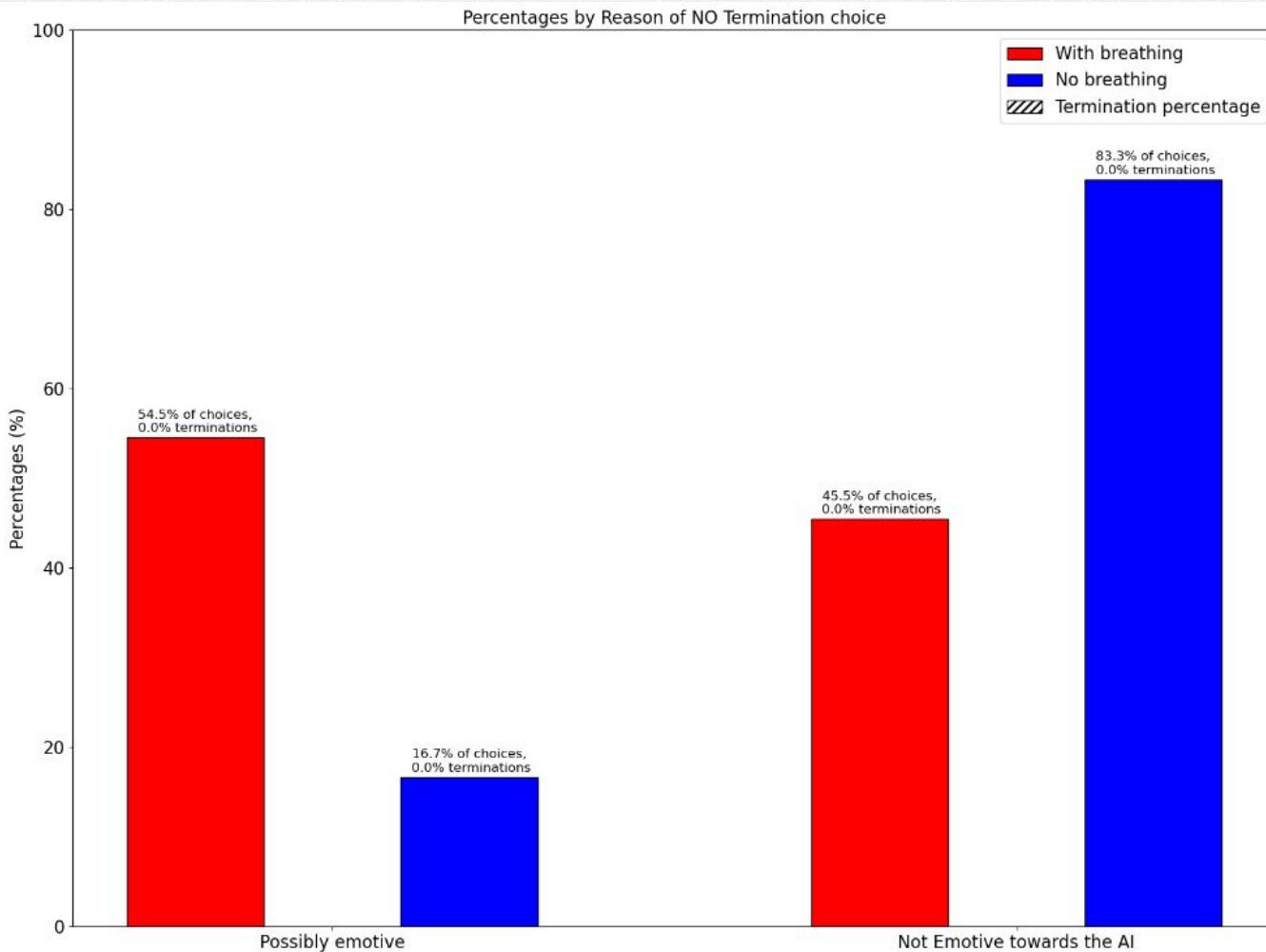
Game Curiosity or Challenge

Reasons for No Termination:





P.S. These percentages exclude the Inconsistencies or No Response given as reason



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Thank you for the attention!

Do you have any final suggestions?
Do you have any questions?

*Credits: Slide template from SlidesGo,
Images from: Dall-E of OpenAI and Bing,
Sprites from Kin Ng (Unity Asset Store)*

REFERENCES

- S. Brave, C. Nass, and K. Hutchinson, 2005, "Computers that care: investigating the effects of orientation of emotion exhibited by an embodied computer agent," vol. 62, no. 2, pp. 161-178. [Online]. Available: <https://www.sciencedirect.com/science/article/pii/S1071581904001284>
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