Opening Computational Neuroscience to a Wider Audience: Virtual Escape Room for Kids

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Abstract:

As researchers it is vital that we increase the accessibility, transparency, diversity, and inclusivity of our work. One-way Neuromatch has championed this is by having outreach sessions for children (8+) to explain computational-neuroscience concepts.
For the 2022 Neuromatch conference we designed an online escape room with the two goals 1) to show who is a neuroscience researcher and what they do and 2) to explain a research topic. To show who/what is a researcher, the escape room began with a video describing the day-to-day life of a researcher. The subsequent videos discussed how mathematics and neuroscience are combined to model decision-making. We framed the videos around the question "Will I walk or bike to school?" to describe the concepts of the drift-diffusion equation and how its application. At the end of each video there was a multiple-choice question, a correct response gave clues to the next image and a letter for the keyword needed to complete the escape room.
The escape room was translated into six languages: Arabic, Chinese, French, English, Hebrew and Spanish. The materials have been made open access and can be easily adapted to create content to communicate other scientific research questions to a broad audience.
Keywords: Computational Neuroscience; Drift-Diffusion Equation; Decision-making; Science Communication; Outreach; Equality, Inclusion and Diversity.

Introduction

To foster curiosity and interest in science in a wider range of learners, it is crucial to make science education accessible and inclusive to all, regardless of their language, age, or background (Gaudelli, 2014). Children, in particular, are naturally curious and eager to explore the world around them, and early exposure to science can help encourage their curiosity and pave the way for future progress in a wide range of scientific fields (McClure, et al 2017).

Neuromatch's mission is to increase the accessibility, transparency, diversity, and inclusivity in global scientific conferences and summer schools both within neuroscience and other disciplines (Achakulvisut et al. 2020, 2021, t' Hart et al 2021, van Viegen et al. 2021). As part of the outreach session at the 5th Neuromatch Conference in 2022, we designed an online escape room for 8+ years.

The Escape Room had two educational and communication goals:

1. To talk about who is a neuroscience researcher and what do researchers do day-to-day.
2. To illustrate how a computational neuroscientist approaches a research question, we described the application of the drift-diffusion equation for decision-making.

To ensure a diverse and inclusive reach, the escape room was translated into six languages: Arabic, Chinese, French, English, Hebrew, and Spanish. Here we outline how we designed the virtual escape room and how we linked the mathematics and neuroscience into bitesize conceptual components.

Virtual Escape Room Design

The escape rooms were created by ten researchers and volunteers at Neuromatch working remotely from around the world. Each escape room consisted of a primary webpage that had 7 targets and 2 decoys embedded images (Neuromatch 2022). The clickable targets lead to a google form (Figure 1). Each google form consisted of a video presentation ranging in length from one to three minutes followed by a multiple-choice question.

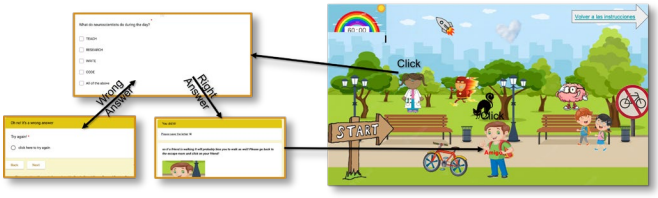

Figure 1: Left Example google form with embedded question. Right Escape room main page with clickable objects.

The presentation slides were designed with minimal text and simple animations made with Python and Matplotlib (Harris et al., 2020; Hunter, 2007) to allow for accessibility and easy translation into the six (Arabic, Chinese, French, English, Hebrew, and Spanish) languages (Figure 2).
A correct response of the multiple-choice question would give clues to the next image and a letter that was part of a keyword. To complete the escape room, participants need to find the seven different images watch the seven videos; answer the multiple-choice questions correctly and decrypt the keyword to be awarded a Certificate of Escape.

Figure 2: Example slides in Arabic, Chinese, English, French, Hebrew and Spanish.

The short presentations were also designed to be a single contiguous talk which can be presented in

person. Furthermore, to increase accessibility the videos were uploaded to YouTube and Bilibili for people in mainland China. The presentation was divided into two sections, the first about who we are and what we do as neuroscience researchers and the second about a research question.

Who We Are and What We Do

The first section of the escape room outlined the day to day of a researcher's life, touching on what we teach, research, code, write and that we collaborate. Also, the presentation mentioned the 10 researchers that contributed to the escape room who were at different stages of their research career (Undergraduate, MSc, PhD, Postdoctoral and PIs) and from Asia, Europe North Africa, North and South America and working in many different locations around the globe. Furthermore, for the English escape room each short video was presented by a different person giving a flavor of the different voices in science. Finally, on the landing webpage for the escape rooms each of the contributors wrote a short bio in their native languages which were Arabic, Chinese, Dutch, English, French, Hebrew, Irish, Japanese and Spanish (Neuromatch, 2022). Further illustrating there is no one single version of a scientist or one language for science.

Research Question

The research question of how the drift-diffusion equation is used to model decision-making was chosen to illustrate the synergy between mathematics and neuroscience. The drift-diffusion is a first order stochastic differential equation given as:

$$\frac{dx}{dt} = \mu x + \sigma \frac{dW}{dt},$$

where x(t) is the decision variable, μ is the drift rate, σ is the variance and $\frac{dW}{dt}$ is the Wiener process, with a given initial condition at time 0. While the mathematical notation in this equation might be intimidating or considered beyond the capacity of a younger and broader audience the concepts can be explained using graphs and plain language (Figure 3).

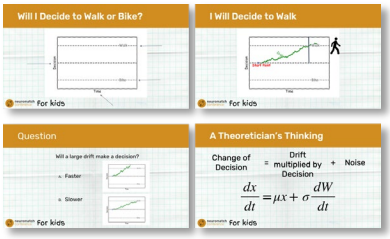

Figure 3: Example slides illustrating the graphs and the use of plan language to explain mathematics.

Here we framed the research question around having to decide "will I walk or bike to school" [1,2]. This allowed us to breakdown the parameters and aspects of drift-diffusion equation linked to the decision-making process into six videos:

1. Will I Walk or Will I Bike? (Drift rate and Decision Time),
2. Cannot Make a Decision? (No Input/Noise),
3. A Sunny Day? (Shift of Initial Condition),
4. Will I Change My Mind? (Evidence Change),
5. Time's Running Out? (Stopping Criteria),
6. Siblings Deciding? (Competing Decisions).

In each video a question is first posed, and the possible answers are discussed in plain language then the mathematical concepts are brought in and illustrated using simple animated graphs. Each video contained a multiple-choice question a correct response gave clues to the next image to be found and a letter for the keyword required to complete the escape room.

Conclusions

The Neuromatch virtual escape room was a resounding success in promoting accessibility, diversity, and inclusivity in science education, and the positive feedback from participants highlighted the effectiveness of this creative and engaging approach. Moreover, the escape room, slides, and materials were designed to be easily adapted and extended to communicate different scientific research questions to a broad audience, making them invaluable resources for science outreach and education. In future version we would like to get more stakeholders involved in the development process like parents, teachers and especially children. Initiatives like this can help pave the way for a more equitable and diverse future in science.

Acknowledgements

We thank all the people who participated.

[1] As the escape room was released coinciding with Rosh Hashanah the Hebrew Version used the question "Will I Have Pomegranate or Apple with Honey?

[2] The senior author has also done a version of the talk for an older audience in a pub using the question "Will I Have Another Pint or Go Home?"

References

Achakulvisut, T., Ruangrong, T., Mineault, P., Vogels, T. P., Peters, M. A., Poirazi, P., ... & Kording, K. P. (2021). Towards democratizing and automating online conferences: Lessons from the neuromatch conferences. Trends in Cognitive Sciences, 25(4), 265-268.

Achakulvisut, T., Ruangrong, T., Bilgin, I., Van Den Bossche, S., Wyble, B., Goodman, D. F., & Kording, K. P. (2020). Improving on legacy conferences by moving online. Elife, 9, e57892.

Gaudelli, W. (2014). World class: Teaching and learning in global times. Routledge.

Harris, C. R., Millman, K. J., Van Der Walt, S. J., Gommers, R., Virtanen, P., Cournapeau, D., . . . others (2020). Array programming with numpy. Nature, 585(7825), 357–362.

Hunter, J. D. (2007). Matplotlib: A 2d graphics environment. Computing in Science & Engineering, 9(3), 90–95. doi:10.1109/MCSE.2007.55

McClure, E. R., Guernsey, L., Clements, D. H., Bales, S. N., Nichols, J., Kendall-Taylor, N., & Levine, M. H. (2017). STEM Starts Early: Grounding Science, Technology, Engineering, and Math Education in Early Childhood. In Joan Ganz Cooney center at sesame workshop. Joan Ganz Cooney Center at Sesame Workshop. 1900 Broadway, New York, NY 10023.

Neuromatch. (2022, September). "Neuromatch for kids" https://conference.neuromatch.io/instructions/nmc-kids-escape-room

t Hart, B., Achakulvisut, T., Adeyemi, A., Akrami, A., Alicea, B., Alonso-Andres, A., ... & Vishne, G. (2022). Neuromatch Academy: a 3-week, online summer school in computational neuroscience. Journal of Open Source Education, 5(49), 118.

van Viegen, T., Akrami, A., Bonnen, K., DeWitt, E., Hyafil, A., Ledmyr, H., ... & Peters, M. A. (2021). Neuromatch Academy: Teaching computational neuroscience with global accessibility. Trends in cognitive sciences, 25(7), 535-538.