THE EFFECTIVENESS OF REPRESENTATIONS OF ABSTRACT BIO-CHEMICAL PROCESSES IN EDUCATION

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Abstract

The representations of biomedical processes must balance visual portrayals with descriptive content to be an effective learning tool. To determine what type of representation is the most suitable for education, we designed five different representations of adenosine triphosphate (ATP) synthesis and examined how they are perceived. Our representations consisted of an overview of the process in a detailed and abstract illustrative format, continuous video formats with and without narration, and a combined overview with dynamic components. The five representations were evaluated by non-experts who were randomly assigned one of them and experts who viewed and compared all five representations. Subsequently, we conducted a focus group on the outcomes of these evaluations, which gave insight into possible explanations of our results, where the non-experts preferred the Detailed Static representation and found the Narrated Video least helpful, in contradiction to the experts who favored the Narrated Video the most.

❖ Is it more beneficial for learning to view the biochemical processes continuously or as an overview scheme showing the main phase of the process?
❖ Is there a difference between user groups with varying levels of knowledge in preference for static or animated representations?
❖ Is there any preference for abstract or detailed representations between the expert and the non-expert groups?

Study Design

Two iterations of online surveys consisted of non-experts (n=60) with randomly assigned representation, experts (n=9) with all five representations (*Figure 3*), and a focus group discussing the previous results, improvements and use of the representations. The five representations were arranged in a continuous manner (Narrated Video and Video), overview (Abstract and Detailed Static), and their combination (Hybrid), as represented in *Figure 1*. The QR code (*Figure 2*) will take you to the website containing all five representations.
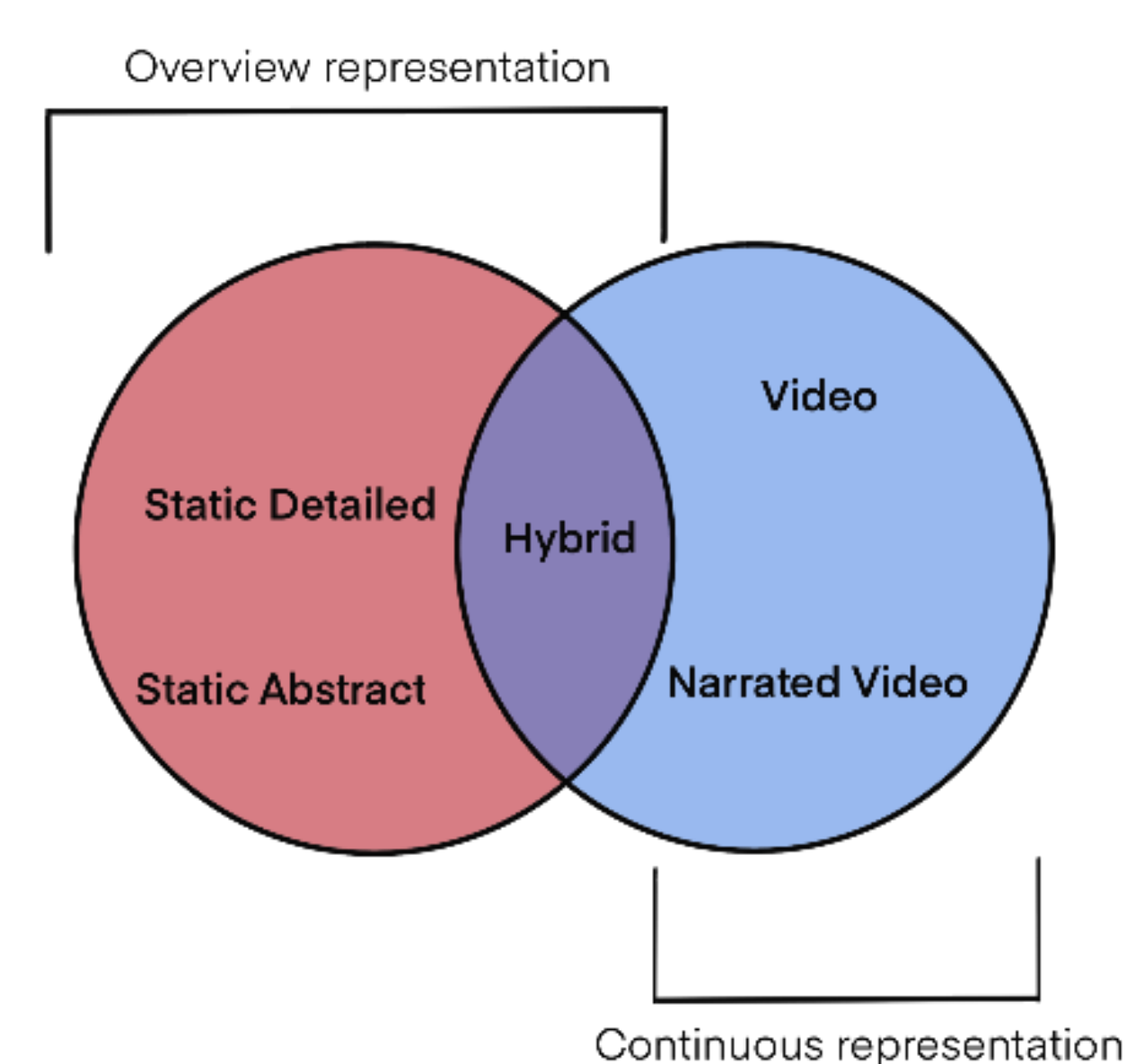

Fig.1: The division of categories of the representations.

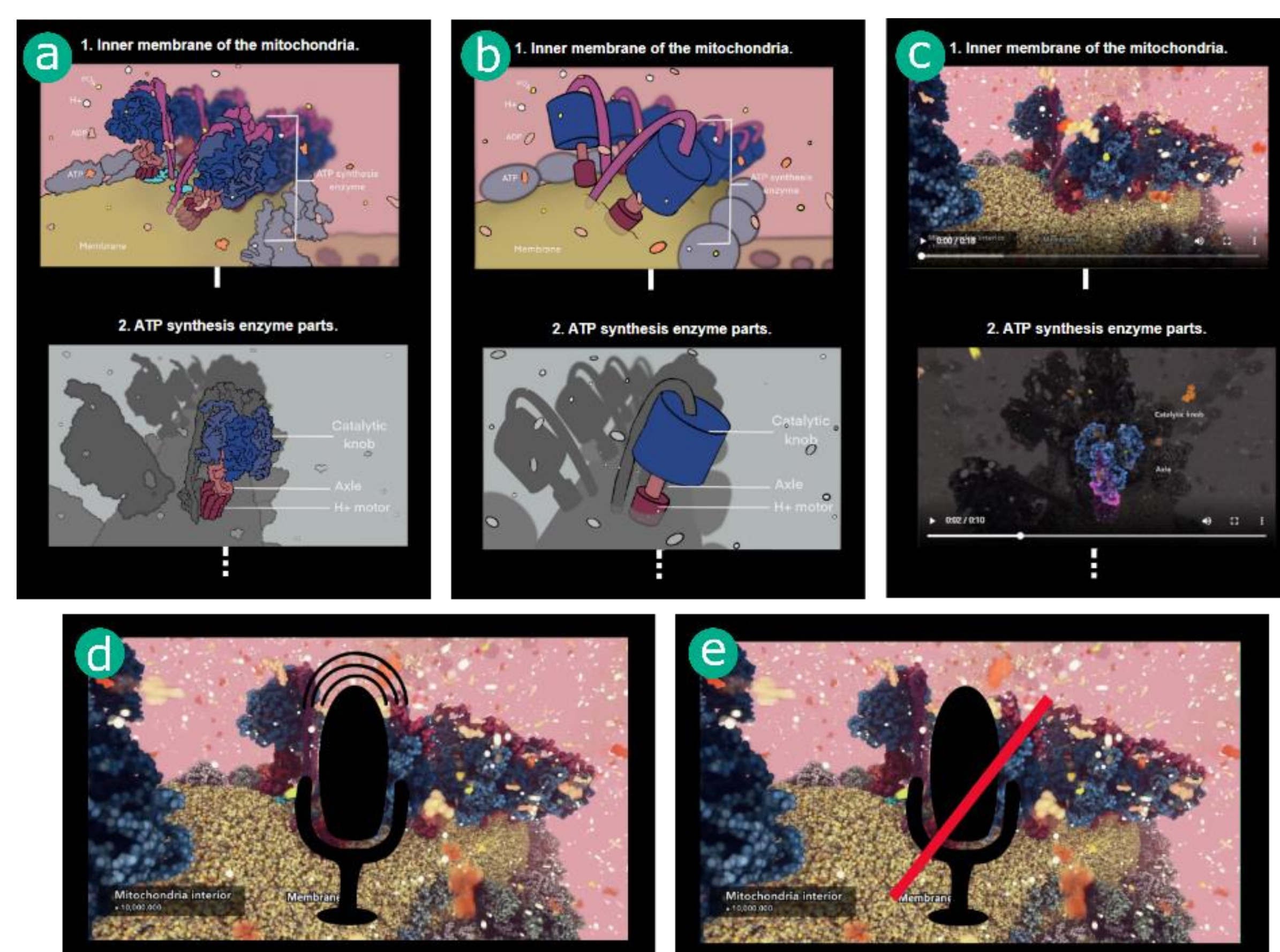
Fig.2: QR code linked to a website with representations.

Fig.3: Overview of the five representations a) Static Detailed, b) Static Abstract, c) Hybrid, d) Narrated Video, e) Video.

Results

Our results have shown a preference for Static Detailed for the non-experts and Narrated Video for the Experts. The Narrated Video was the least favorite among the non-experts. The focus group assumed that the Narrated Video was too fast and that the non-native speakers had a disadvantage. Post-hoc tests determined that the language barrier was not an issue.

Results: Non-experts

	Order (rating)	Movement (rating)	Content score in %	Order score in %	Overall score in %	Positive comments	Negative comments
Detailed Static	3.79	3.42	64.88	78.57	71.73	step-by-step presentation; arrows in images and labels; not visually cluttered	too detailed; too much information
Abstract Static	4.08	3.58	60.61	68.18	64.39	images helped to complete the task; simple style	confusing; too simplistic; hard to distinguish between molecules
Hybrid	3.50	3.30	53.70	86.11	69.90	simple steps; colours	distracting music; hectic; too many details; most information from text; distracting animations; no narration
Narrated Video	2.62	3.39	52.56	46.15	46.64	realistic; cool; motion; music; written and narrated	too fast; dramatic; subtitles wanted; chaos; busy; difficult to understand without biochemistry background
Video	2.36	2.91	59.09	50.00	53.41	realistic; sounds; colours	dramatic music; too many things happening; going back and forth in the video; difficult to understand without biochemistry background

Results: Experts

	Overall preference	Order	Movement	Positive comments	Negative comments
Detailed Static	N=2	N=1	N=0		very confusing; visually crowded, without values, depth of field bad (bad 3D)
Abstract Static	N=1	N=2	N=0	good for teaching basics	too simple; not for deep understanding; oversimplified to the point of misleading
Hybrid	N=4	N=3	N=1		
Narrated Video	N=5	N=3	N=8	realistic representation; space/movement; most descriptive; clearest; step-by-step without switching between content; dynamic changes; narration gives information	overload
Video	N=3	N=0	N=0		lot of change simultaneously; need to re-watch

Results: Focus Group

	Education	Printed media	Public
Detailed Static	6	3	2
Abstract Static	3	5	3
Hybrid	5	1	2
Narrated Video	6	0	8
Video	4	0	3

Conclusion

Based on our qualitative and quantitative data from non-experts, qualitative data from experts, and discussion in a focus group, we have concluded that non-experts prefer the overview approach as it allows them to learn at their own pace. The Narrated Video contains information familiar to the experts, and therefore it was favored by that target group. We suggest that the best learning tool would be using the Static Detailed representation followed by Narrated Video; a combination of using two representations consecutively rather than using a combination of two techniques like in the Hybrid representation, which we expected to be deemed as the most useful by both target groups with different level of experience.

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