Influence of Expertise on Perception and Understanding on Viewing a Molecular Animation of the Lung Endothelial Surface Layer and its Role in Inflammation

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Abstract

At the University of Illinois College of Medicine Anesthesiology Research Department, lung trauma researchers aimed to generate interest in the importance of the lung endothelial surface layer in inflammation. However, they had difficulty describing the dynamic molecular structure of the lung endothelial surface layer and its role in inflammatory processes in the lung. A 3D animation was created because of its ability to communicate a rich and complex molecular narrative (Iwasa, 2015). Prior studies have shown that, for scientific animations, level of expertise of the viewer influences how an animation is perceived (VandenPlas, 2008). This study aimed to improve lung trauma researchers' ability to generate interest in their research and to assess if prior knowledge affects how biomedical animations are perceived in terms of engagement by analyzing eye-tracking.

Purpose

The purpose of this research was to determine:

- Will a 3D animation generate interest in the lung endothelial surface layer (ESL) and its role in inflammatory processes?

- Does a difference exist between experts and novices in terms of the areas of interest (AOIs) they fixate on when viewing the animation on the lung ESL surface?

Research on the lung ESL has only recently picked up interest because its delicate nature makes it difficult to study and image. In cases like this, where good imaging is not possible 3D animation is perfect for explaining molecular structure and function (Iwasa, 2015).

3D molecular animations are popular, but analyzing their effectiveness quantitatively has not yet been done. Since meaning guides where people look, and experts are better identifying relevant areas of interest than novices, using eye-tracking allowed us to identify what experts find meaningful in the 3D animation (Hyona, 2010).

Methods

Fig C. 3D models of the core components of the glycocalyx and endothelial cells that make up the lung ESL.

The highest resolution electron micrograph images of the glycocalyx (**Fig A**) and measurements from published literature were used to create 3D and 2D representations of the Endothelial Surface Layer on endothelial cells at a variety of scales (**Fig C**).

Methods Cont.

Fig D. Still of the endothelial cell junction (left) which was designed to mimic common schematics used in the scientific literature (right) (Giannotta, 2013).

We used eye-tracking with Gazepoint GP3 to record and visualize where people looked while watching the animation (top left). The content expert approved the hypothesized areas of interest (AOIs) to experts on the storyboard (bottom left). Those areas of interest were encoded onto the animation (bottom right). We used cued retrospective reporting to determine why they felt they looked there. Both groups had their eye-gazes recorded while watching the animation. After the first watch they rewatched the animation with their eye-tracking data overlaid and commented on why they felt they focused on certain aspects (top right). Pre-test and post-test surveys and quizzes were used to test knowledge gained and engagement level.

Fig A. The highest resolution electron micrograph of the lung ESL in the cross-section of a blood vessel.

Fig B. Eye-tracking shows fixations (circles) and paths between fixations.

We analyzed the knowledge gain on the surveys, average number of fixations within areas of interest, and segmented the AOIs by categories.

Results: Data

Engagement increased with expertise level.

Table A. Survey Results on Engagement

	Researchers (n= 5)	Novices (n= 15)
Extremely engaging	40.0%	
Very Engaging	40.0%	26.7%
Moderately Engaging	20.0%	66.7%
Slightly interesting		6.7%
Not interesting at all		

Trend: Researchers switched to one modality (audio or visual) to seek information when shown representations that they were familiar with from the literature.

Expert fixating on animation because they are focusing on gaining new information from the animation.

Expert fixating on one point because they are focusing on gaining new information from the audio.

Results: Evaluation

Researchers paid special attention to endothelial cells and the "the barrier representation", the path of plasma proteins through the ESL and past endothelial cells, the size of neutrophils, and clinical care footage, diagnostic images (chest x-rays).

Summary

The animation was successful at generating interest in the Lung ESL. The expert group found it more engaging, while the novice group was less engaged (**Table A**). Eye-tracking and surveys allowed us to determine what was especially engaging to the experts (**Results: Evaluation**) and revealed that when presented with familiar representations (**Fig. D**) experts switched to focusing on the audio or the visuals, depending on which modality they expected to learn new information (**Results: Data**). Therefore, when designing animations on the Lung ESL, particular care for accuracy should be taken with creating realistic scale, characteristics and colors of endothelial cells, subglycocalyx areas, neutrophil size, plasma proteins trajectories through and past endothelial cells, "clinical care footage", and chest x-rays as these will be especially scrutinized for information by expert audiences.

References

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