Article that cites Chandler et al.'s "Immersive Analytics"
Title: Immersive Analytics for the Ecological Cognitive Stimulation Approach
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Main Contributions: This paper looked at using immersive analytics to create adaptive virtual environments for treatment of mild cognitive impairments, such as Alzheimer's, in older persons. Current methods for delaying the negative effects of Alzheimer's consist of a therapist or psychologist working with a group of patients on a set of cognitive exercises. These activities are carried out using flashcards or pencil and paper. Very few of these activities make use of technology. In addition, they are not adaptive and do not change depending on how the patient is feeling. These limit traditional methods. In this paper, the authors seek to create a new method of cognitive stimulation that integrations elements of a person's natural environment with interactive immersive analytics.

The system presented in this paper is an immersive virtual environment, modeled based on a real environment that the user often finds themselves in, that offers potential benefits related to better understanding how patients perceive and respond to various factors in their environment. The environment has the ability to adapt to the context and profile of the patient based on their performance in different cognitive activities using data obtained by various sensors within the CAVE virtual reality system. Throughout the immersive experience, the user has an occluded view of his own body when interacting with the virtual objects to allow the user the opportunity to navigate in a large virtual space using his entire body. A user is able to navigate through the virtual environment either by physically walking through the CAVE or by using a baton as a control device that allows them to move over distances greater than those allowed by the CAVE.

The user, a Leap Motion sensor, and an unspecified emotion sensor exist in the natural environment, outside of VR. During an activity, these sensors inform agents in the VR environment that consult a database to identify potential problems and offer appropriate help by providing the user with hints to aid in overcoming difficulties. The authors illustrate how the virtual environment may work by presenting a scenario. Imagine the VR environment is modeled to simulate the user's house, where he is tasked with looking for his glasses. The sensors detect how close the user is to finding the glasses, and emotions such as frustration. Data gathered from the sensors are also used to know when the system should offer hints, so as to not discourage the user from completing the activity. If the emotion sensor detects that the user is getting frustrated because he cannot find his glasses, the system may use objects within the virtual environment to draw the attention of the user and help him locate them. Both visual and audio cues are used to draw the user's attention to particular objects.

How does it present its contribution as related to immersive analytics?: As mentioned in the previous section, traditional therapy methods for mild cognitive impairment involve flashcard and paper/paper activities that are directed by therapists. These activities lack consideration of the person's natural environment. Immersive analytics is used in this paper to provide therapy activities that are related to situations that the user finds themselves in frequently. This may

help improve cognitive stimulation and may help the user be able to better transfer the skills they learn by using the system because the scenarios are relevant to their day-to-day activities, as opposed to the flashcard activities, which are designed to be used by all patients. Since the user is completely immersed in the environment, the authors believe that the activities will feel more relevant and engaging than those presented using flashcards. And the use of the sensors allow for the system to be personalized to each user, offering more potential learning benefits as well.

Why does it cite Chandler's paper?: This paper cites Chandler's paper in making an argument for the different uses of immersive analytics. The authors point to different scenarios that are mentioned in the Chandler paper and they go on to say that they propose the integration of immersive analytics into their system to make cognitive stimulation activities more natural to the user.

What methodologies are used?: This paper does not mention the technical methodologies they used to create their system. However, they do mention methods from cognitive stimulation that they took into consideration when designing the system, such as enabling users to improve their performance on everyday tasks and preserve an optimal level of autonomy despite cognitive decline. The methods from cognitive stimulation that they took into account are optimization of cognitive functioning (memory, attention and language), improvement of performance on tasks, preservation of autonomy, and transfer of skills and performance outside of the virtual environment.

Is the evidence convincing and are the results compelling?: The evidence is not convincing. The authors do not test their system with any users or present any information that suggests they did background research by talking to professional therapists who work with older persons with cognitive decline. This tells me that their system is based on hypothetical ideas and draws only on their literature review and common knowledge about the methods used when working with individuals with cognitive decline. I also found that the paper was hard to read, and the ideas difficult to follow. The system design is confusing, and the lack of pictures makes it even more difficult for me to visualize what the system may look like. The pictures that are presented felt overwhelming to look at because the authors did not parse out the relevant information from those pictures. Instead, they present every small detail regarding the system design, many of which do not actually contribute to my understanding of how the system is designed or intended to be used. Additionally, some of the claims presented by the paper are not supported. For example, the authors mention earlier in the paper that their system would be able to support collaboration. However, it is not clear how the users would go about collaborating using the system. Would they be able to collaborate within the virtual environment with other patients? With therapists? Family members? This is brought up once and not immediately supported. I do not feel like the results of the paper are compelling for the same reasons that I do not think that the evidence is convincing. I do think, however, that the potential use of VR framed by this paper is extremely compelling. As someone who is involved in assistive technology research, I do see various use cases for this kind of technology, and the ideas presented by the authors do seem viable.

Article cited by Chandler et al.'s "Immersive Analytics"
Title: Immersive and Collaborative Data Visualization using Virtual Reality Platforms
Authors: Ciro Donalek, S.G. Djorgovski, Alex Cioc, Anwell Wang, Jerry Zhang, Elizabeth Lawler, Stacy Yeh, Ashish Mahabal, Matthew Graham, Andrew Drake, Scott Davidoff, Jeffery S. Norris, Giuseppe Longo
Publication: IEEE International Conference on Big Data, Oct 27-30 2014 in Washington DC, USA

Main Contributions: This paper looks at the use of immersive virtual reality platforms for scientific data visualization using multi-dimensional data sets. The authors claim that immersive virtual reality can enable collaborative data visualization and leads to better data understanding than traditional tools. Their main research question is: "How do we visualize interesting structures and patterns that may exist in hyper-dimensional data spaces? They frame their claim as: "It [immersive visualization] leads to a demonstrably better perception of a datascape geometry, more intuitive data understanding and a better retention of the perceived relationships in the data".

The authors first conducted some experiments with off the shelf virtual worlds. One of the ones they used is an OpenSimulator based tool, vCaltech, for visualizing 8-dimensional data sets using a small avatar that navigates through the data. The authors were able to use this tool to visualize data by mapping the data onto X, Y and Z locations, shapes, colors and transparencies. They were also able to embed links in the data points that would bring up a webpage with additional data for a given object from an external database. However, they noted some limitations, namely that they are not optimized for efficiently rendering visualizations of massive datasets and have limited scripting functionalities as well, which hinders the kinds of visualizations that can be created. These limitations led the authors to begin developing a prototype data visualization tool, iViz, using Unity 3D. The authors point out that one important advantage iViz had over vCaltech is the ability to use a standard web browswer as a display. They noted that this may facilitate adoption of the technology, especially by individuals who are reluctant to use VR for data visualization purposes when it seems like the environment is too game-like. The user interface of iViz allows the user to select and shuffle which data parameters are mapped to which XYZ positions, colors, shapes and transparencies in order to determine an appropriate mapping for the data being used. This allows the user to explore their data and experiment.

As a third contribution to the space of immersive analytics and VR, the authors of this paper conducted a study of immersive visualization of Martian landscape in order to compare the potential advantages of immersive VR for displaying data over traditional 2D images. The main objective was to investigate whether the immersive environment allowed scientists to better understand the terrain on Mars, and the authors hypothesized that the scientists viewing the terrain in immersive VR would have a higher situation awareness than scientists using photo panoramas on a computer. They evaluated this hypothesis by having scientists draw, or map, the territory presented in either the panorama pictures or the immersive VR environment.

How does it present its contribution as related to immersive analytics?: This paper is related to immersive analytics because it explores different platforms on which to display immersive

visualizations, and also touches on how immersive analytics could provide a gateway into more collaborative visualization techniques for large data sets. The paper also shows an application of how immersive VR might be able to help scientists explore terrain on Mars. They do not explain how collaboration could be obtained in this scenario but do suggest that exploring the terrain in immersive VR, rather than using 2D pictures displayed on a computer, may help increase understanding and interpretation.

Why does it cite Chandler's paper?: Chandler et al. cite this paper to argue their claim for using immersive analytics for collaborative data visualization. The Chandler paper uses this paper to highlight some of the preliminary work that has been done in VR related to collaboration. They also use this paper to point out a research gap that their paper attempts to fill. This is what the Chandler paper says regarding this paper: "Donalek et al. [25] published a progress report of the exploration of VR as a collaborative platform for information visualization…Their studies are still at an exploratory level and thus the authors did not provide evidence of how effective this system is for collaborative visualization of big and complex data".

What methodologies are used?: This paper is not specific about the methodologies used to evaluate vCaltech and iViz. However, they do mention that for the experiment studying terrain on Mars they used a 2 by 1 between subjects design. Participants were scientists who had participated in the Mars Exploration Rover and Mars Science Laboratory missions as geologists and science planners. These participants were selected using snowball sampling. Scientists in both groups were presented with photographs of mars terrain. One group was asked to manually map the terrain, while the other group was asked to map the terrain using a map of Mars that was designed and implemented in Unity. It seems that a lot of the methodologies used to carry out the work in this paper were highly experimental. The authors started with vCaltech, noticed some limitations, and expanded that work by creating iViz in Unity. They then experimented with the data in iViz, including the use of a Leap Motion sensor, a 3D mouse and a Kinect. They used results of these experiments to speculate uses for immersive analytics and VR.

Is the evidence convincing and are the results compelling?: It is hard to say whether the results of this paper are convincing, since the paper is an exploratory survey paper. The authors do not test one of the main systems they mentioned, iViz, with any users. They did conduct a user study with the Mars terrain project. The results of this user study showed that the scientists seemed to perform better in the immersive VR environment when asked to map out the Mars terrain. However, "self-reports from the scientists themselves were ambiguous". It was not clear from the paper what these self-reports were measuring, but my assumption is that they were measuring either the ease with which the scientists were able to map the terrain in the two different conditions, or how confident the scientists felt about the accuracy of the terrain maps. I did not find the results compelling because they do not point to new discoveries for immersive or collaborative analytics. However, I did enjoy learning about iViz and thinking about the potential uses for these kinds of technologies. This paper does a great job of speculating and setting the stage for future work that could be done.