Efficacy of Virtual Reality Learning

Prepared for: Duane Mathes, CEO
Prepared by: Casey Burkett, LCPC, NCC, Librarium Research and Learning Advisor
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EXECUTIVE SUMMARY

Objective

Evaluate and compile current best practices in effective learning strategies, use of memorization aids and strategies, and skills and techniques for managing and reducing distress associated with learning and test taking.

Goals

- Provide direction to development team to incorporate best practices from inception to execution, integrating every tool possible to help users achieve learning goals.
- Encourage potential investors to consider the vast amount of research supporting Librarium's unique position to bring reliable learning and memorization methods to a new platform with nearly unlimited growth potential.

Outline

This report contains:

- Research highlights supporting Memory Palace design, use of mnemonics and other memorization aids
- Innovative tools unique to virtual reality
- Best practices for effective learning strategies
- Application of mental health strategies for improved test performance
- Additional resources and bibliography

RESEARCH HIGHLIGHTS

In the beginning

The earliest known descriptions of the **method of loci**, written by the ancient Greeks and Romans, feature strolls through real and imagined settings associating unique features of the experience with sets of items the learner wants to recall. By forming a relationship between the information to be recalled and an image of a real or imagined place, the learner is reported to increase the reliability of recall. *Loci* in Latin refers to places or locations, which continues to be the foundation of the technique, and further development of this method has shown that integrating additional cues such as visual or auditory details increase recall reliability. World-class memorizers have shared methods that begin by developing an imaginal **memory palace** which may have many rooms and hallways that they develop repetitive routes through, placing items of significance along the route, and then associating the space, route, and item to the recall item. Additional cues like **mnemonics**, absurd or outrageous cues, and interpersonal connections are also reported to improve recall.

Further developments

Today's neuroscience researchers report memory training reorganizes the brain's functional network to enable superior memory performance, driving distributed rather than regional changes[1]. Meaning, not only are the areas of the brain dedicated to memory reorganized, overall brain network connectivity is also improved. This same study reported increased resting state connectivity with active memory training and hypothesized that invoking naturally evolved strategies like **visuospatial memory** and **navigation** improved the efficacy of memory strategies.

Studies researching the use of head mounted displays (virtual reality) versus desktop displays of virtual memory palaces show that immersion is key to improving recall[2]. One author notes, "An important component of the memory palace technique is the subjective experience of being virtually present in the palace, even when one is physically elsewhere." As research in cognitive psychology suggests that the mind is inherently embodied, it is important to recognize, "The way we create and recall mental constructs is influenced by the way we perceive and move." So while memory training techniques overall show significant improvement to recall and increase resting state connectivity, the immersive nature of virtual reality offers us our first opportunity to bring what has been strictly an imaginal exercise only available to those willing and able to develop this skill to an experience many more learners can engage in. **Lowering the barrier to entry widens accessibility and creates a fun experience that learners of all ages and abilities can benefit from.**

Try it for yourself

Step one: memorize a short story, try to imagine the story as vividly as possible
Step two: associate recall items to events in the story
Step three: Practice, practice, practice (for this experiment, memorize the story well enough to retell it without reading it, tell it again with recall items, check your recall in 5-10 minutes)
Step four: Test recall

The story: You enter your home and the first thing you see is a washing machine, you walk up and open it, it's full of apples, perplexed, you decide to turn it on and the apples turn into juice, suddenly a mad cow appears and demands a glass of juice, as you hand it to him, he grumbles, "I hate Mondays…"

Practice: As silly as it may sound, picture a well known place to you in your mind, your current home, maybe a past home, just a place you have strong images of in your mind. Imagine opening the door and instead of your expected view, there is a clothes washing machine, focus on it and move a little closer, notice as many details as you can, notice what color it is, what brand it is, and take a moment to interact with it, notice what it feels like and take a look inside: Apples? Bring to mind the smell of an apple, notice the color, and any other details. Unsure what to do next and a little curious, turn the machine on, hear the noises of apples banging around in a washing machine. Open the lid again to discover the apples turned into juice. You look up, a mad cow is demanding juice! You hand him a glass, and he grumbles, "I hate Mondays…" Retell in your own words keeping the essential elements, use your location and make it fun!

Recall items: Presidents of the USA in chronological order: Washington, Adams, Jefferson, Madison, Monroe

Practice: Tell the story from memory, visualizing each item and associating Washing machine with Washington, Apples with Adams, Juice with Jefferson, Mad cow with Madison, and Mondays with Monroe. Go through it a few times, noticing new details each time.

Test recall: In 5-10 minutes, see if you can recall the story and each associated item without re-reading the instructions.

While rudimentary, this author has yet to *not* be able to recall our first five presidents since developing this story. In fact, having developed this story more than a month ago, retelling it three times upon conception, and having only recalled it again now, this author found no need to re-look up the order of presidents or otherwise confirm the accuracy of recall. Silliness, absurdity, and fun have all been associated with increasing the accuracy and confidence of recall.

INNOVATIVE TOOLS

What does this look like in VR?

Let's say you are preparing for your National Counselor Exam using a prebuilt learning deck designed to encompass all the subject areas you will be expected to know to receive a passing score. Perusing different study sections, you notice in your performance data that you continue to struggle with recalling Freud's defense mechanisms, so you decide to revisit "Freud's office," a room in your memory palace. After engaging in a brief soft start program designed to induce optimal learning conditions, you appear at the door. Upon entry you may follow a guided path through the room, stopping and interacting with each item. And each time you visit Freud's office, you may perform one of many possible routines. The first level routine includes 20 items in the office, each item a piece of knowledge about Freud himself, his theories, key terms, etc. A second level routine takes you from the office and into one of those items, which starts a new routine through the item itself and includes new items representing new areas of study. For instance, having learned the 20 items in Freud's office and tested recall, you skip the guided path and go straight to the Dieffenbachia plant which sits potted in the corner, distinct in it's leaves and common to households, you realize you're learning a lot even unintentionally, as the deck builder has a pretty wry sense of humor. Dieffenbachia serves as a mnemonic for defense mechanisms, you've also learned the common name for Dieffenbachia is dumb cane because those who attempt to eat it experience a swollen tongue and throat and lose the ability to annunciate clearly (and sometimes breathe, know your plants!). The amusing personal connection you make deepens your connection to the knowledge. You place the plant on your head and begin the second level routine, inside the plant you appear in a large room, the walls are soil and you can see the plants roots, and in front of you is book shelf with an arrangement of 12 items representing each defense mechanism. You go through each item in a repetitive order, simply learning what is on the book shelf. Confident you can recall the book shelf with all 12 items, you begin associating the terms with each item. In your routine you pick up the submarine, struggling to recall the term, you toss the item around, oh, right, submarine, sublimation, you recall the definition, sublimation is taking negative self-concepts and diverting them into more socially acceptable concepts. You connect the transformative nature of the submarine to further connect to the definition. Your last item, an easy one you'll never forget, it's a statue of a dog, easily you recall displacement and can hear your teacher saying, "that's when you're boss yells at you and you go home and beat the dog…"

In each level, fun modifiers help you further improve your confidence and keep your attention engaged. You leave the plant and return having turned on the "mix it up" modifier. This time, all the items are on the floor and you have to return them to the shelf in their original order before connecting the terms. Other modifiers give you terms and allow you to match the item in reverse or allow you to experience challenges that keep your experience lively and rewarding. Mini games offer matching and flash card style learning through the app when VR is not available.

BEST PRACTICES

"When information goes 'in one ear and out the other,' it's often because it doesn't have anything to stick to." — Joshua Foer, Journalist, Author, & Memory Champion

Any quick Internet search regarding learning or memorization tips and tricks will return a slew of best practices for desperate learners wanting to ensure they are not wasting their time studying only to fail to recall the information when it is needed most. One such list from The Learning Center at University of North Carolina offers these ideas:

- Try to understand the information first
- *Link it*
- Sleep on it
- *Self-test*
- *Use distributive practice*
- Write it out
- *Create meaningful groups*
- *Use mnemonics*
- *Talk to yourself*
- *Exercise!*
- *Practice interleaving*
- *Memorable visual images*
- *The memory palace technique*
- *Songs and jingles*
- *The five senses*
- *Lively visual metaphors or analogies*

In traditional studying, the learner not only has to be concerned with the content, understanding it, and then implementing one or some of these techniques, which they also have to take the time to learn and practice, in Librarium each italicized point is integrated into a single study experience. And, rather than the learner taking an additional step to engage a best practice technique, **the best practice technique *IS* the learning experience itself.**

The power of state-dependent learning (SDL)

SDL is a phenomenon related to information processing wherein information acquired in a certain state requires a similar state for best recall. Because such information cannot be reliably accessed under baseline conditions, SDL is manifested as a memory retrieval deficit, however this deficit can be reversed with techniques that reinstate the conditions that were present at encoding[3]. Through Librarium learners can develop repeatable cues and routines that engage the senses, those cues and routines can be repeated in preparation for recall testing by simply using the companion Librarium app. Additionally, typical testing environments can be recreated in Librarium for learners to test their progress and address test related anxiety.

IMPROVING PERFORMANCE

The 4 Cs

"Concentration, confidence, control, and commitment are generally considered the main mental qualities that are important for successful performance,[4]" according to sports psychology researchers looking to improve optimum athletic performance utilizing mind training techniques. They further break down the mental skills needed for peak performance into three levels: Basic skills (I): Attitude, Motivation, Goals/Commitment, People Skills; Preparatory skills (II): Self-Talk, Mental Imagery; Performance skills (III): Managing Anxiety, Managing Emotions, Concentration. Each level builds on the previous and also occur in phases from long-term skill development, immediate preparation for performance, and performing itself. Harnessing mindfulness techniques, performance focused mind training skills, and evidenced-based practices to help users reduce anxiety and manage emotion, Librarium provides learners the opportunity to address underlying performance issues related to the 4Cs.

"You cannot outrun the lion within." -African proverb

Often times we are our own worst enemies when it comes to learning and recall performance. Simply believing you are not able to achieve something is enough to make it become true. By integrating some of the same psychological methods employed by mental health counselors in treating anxiety disorders (skills like power posing, positive self talk, affirmations, breath work, grounding, and exposure therapy), Librarium not only offers learners access to proven memorization techniques, it helps learners overcome interpersonal barriers to learning and recall performance. Take a moment to envision a learning session where, before the user begins the active learning process, they experience a 5-minute soft start program in which to continue they have to hold a powerful pose (picture Superman stance or V-arms) for two minutes, which is proven to improve confidence and mood. While posing, they hear a positive message and are encouraged to engage mindfully, auditory and visual cues further solidify the routine. After posing, the user is taken through a positive visualization and breathing exercise for an additional two minutes in which they reinforce the first exercise and continue to reduce anxiety which further improves likelihood of successful learning and recall. For one final minute, the user is lead through a dancy stretch routine, shaking out the nervous system and preparing the brain for performance. The learner has created optimal internal conditions for having an impactful study session and can easily replicate their soft start routine in preparation for recall aided by Librarium's companion app.

Additionally, post-learning routines including guided meditation, positive state visualization, and movement mindfulness support long-term memory storage and recall performance. Exposure therapy, purposefully creating the anxiety triggering event, has long been the standard for treating phobias and other anxiety disorders, and for Librarium learners it provides the opportunity to practice recall performance in a testing environment while also having the ability to use any of the many skills they have learned along the way. Incorporating alternating bilateral stimulation, the foundation of a trauma processing therapy known as Eye Movement Desensitization and Reprocessing, gives the user even more ability to work toward solidifying positive mental states and improving performance.

ADDITIONAL RESOURCES

Check your own recall

If you took the time to work with the practice exercise, assuming you continued to read until this point, now may be a good opportunity to test your recall. Consider checking it in a few days as well, see what you notice for yourself. If you find this technique effective, imagine having had it prior to those make or break moments in your own life, imagine having had the tools to build confidence in your abilities and the ability to use the tools of the highest performing learners.

Librarium resource examples

Librarium learners will have access to skill sets from several different categories, here are a few examples to practice with:

- 4-7-8 breathing:

    1. Find somewhere comfortable to sit. If comfortable, close your eyes.
    2. Breathe in through your nose to the count of four.
    3. Hold the breath to the count of seven.
    4. Exhale through your mouth to the count of eight.

In VR this basic instruction becomes an embodied experience teaching the learner to create a positive baseline for each learning experience. For this non-VR practice, simply notice your current mood and the general state of your mind before practicing, find a comfortable and stable position, and starting with a diaphragmatic inhalation through your nose, count to yourself to the number 4. Hold your breath, counting to yourself to the number 7. Slowly release your breath, pursing your lips to restrict the outflow, and counting to yourself to the number 8. Repeat two more times, then return to natural breathing. Reassess your mood and the state of your mind, notice any shifts. Repeated practice will improve overall effectiveness.

This exercise works on several different levels: slow deep diaphragmatic breathing triggers a parasympathetic response inducing a more relaxed state. Internal counting disrupts receptive thought patterns and gives the brain an opportunity to reset. Noticing shifts in mood and mental state improves internal awareness.

- Mental Rehearsal & Positive Visualization:

Studies[5] have demonstrated that when college level basketball players are instructed to supplement their practice time by mentally rehearsing throwing free throws and positively visualize making each basket, they improve their overall accuracy, even more than their peers who spend the same time practicing actual free throws. For this practice, close your eyes if comfortable, take a moment to notice your breath (4-7-8 can be helpful), think about an upcoming event, maybe something with pressure to perform well. Think back to a time when you felt you accomplished this task with great success, remember what you did and how you did it, remember how you felt,

remember the details. Now picture yourself accomplishing this upcoming task with the same level of superb execution, imagine yourself feeling confident and proud! Repeat for just a few minutes a day until the task arrives.

And for a moment, imagine practicing this exercise after every Librarium study session, cooling down from active learning while engaging positive visualization and rehearsing high performance recall creates optimal conditions for experiencing a similarly confident state when performing under pressure.

- Power Posing

Researches have demonstrated the powerful link between our perceived sense of self and body posture, noting that when assuming a low power posture individuals tend to experience more negative thoughts about self and when individuals intentionally stand or sit in a powerful position, they tend to experience a more positive view. Further, when individuals power posed for 2 minutes prior to an evaluative scenario they were rated higher by evaluators than those who did not. Studies have even shown that holding a pen or pencil in your mouth for a couple minutes causes people to report improvement in mood. If you're feeling brave, just drawing back your cheeks until a slight smile appears is enough to notice the connection of mind and body. Librarium learners will have every resource to create optimal learning states and have confidence in their recall abilities.

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