

**Marching to a Different Drummer: A Proposal For Rhythm Game-Based Therapy Using
EMDR as a Model**

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On my honor as a University Student, I have neither given nor received unauthorized aid on this
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Overture

Anxiety, phobias, and trauma are a widespread issue for much of our society; Solomon and Davidson found that PTSD alone may have impacted anywhere from 1% to 12.3% of the general population (1997, p. 7); in addition to being debilitating, this condition is known to more often than not be comorbid with other psychiatric disorders. Lavin's (2012, p. 30) more recent studies suggest that around 7% to 8% of Americans will experience PTSD. These disorders can be incredibly disruptive to an individual's function, relationships, and well-being (Lavin, 2012). To further complicate matters, while psychological therapy is becoming more socially accepted, there are multiple layers of stigma still attached to seeking help, both self-inflicted and inflicted by one's peers (Owen et al, 2012). Therapy can also involve a demanding, uncomfortable intensity of self-reflection, and not every form of therapy is suitable for everyone. These are issues that I have experienced on a personal level, and I've begun to wonder if the casual methods I use to deal with my anxiety flare-ups outside of counseling could prove to be useful to the broader population. Over the past few years, I've come to realize that after a session of playing certain rhythm-based video games, I find myself more capable of approaching an academic or personal problem. I don't think I'm imagining it; this form of play feels therapeutic. While I possess neither the time nor the resources to perform a definitive analysis of these systems as a form of therapy, I want to at least create a theoretical foundation for any potential research.

More Than Idle Play

There is some literature regarding video games in general being used as a form of attention training. During a 2017 study by Parong and Mayer, the researchers found that individuals who played a game designed to teach the player to shift between competing tasks showed improved performance on traditional cognitive tests compared to the control group, while other studies showed a notably higher rate of improvement of visual attention skills (Green and Bavelier, 2003) and spatial distribution of attention (Green and Bavelier, 2006) in gamers versus their non-gamer counterparts. Furthermore, while controversy lingers in the academic and lay communities over the claim that video games can cause Attention Deficit Hyperactivity Disorder (ADHD), there is evidence to suggest the contrary; in an experiment comparing gamers versus non-gamers on their performance on traditional ADHD screening tests, gamers made faster responses and were no less accurate than non-gamers, suggesting that the gamers actually had a better attention capacity (Green and Bavelier, 2012). Of course, the academic community is not wholly in agreement on the idea that video games can function as brain training (Murphy and Spencer, 2009), but I feel there is more than enough evidence to merit continued investigation.

Rhythm games, which are video games that require the player to make inputs based on timing and beat, are surprisingly complex when it comes to how they create an environment for the player. I've observed that rhythm games and other games heavily reliant on sound design employ some interesting techniques to create a three-dimensional state through auditory stimuli. These techniques differ between individual games, usually either due to the design choices of the developers, or due to the limitations of the audio hardware involved. My preferred way to

distinguish between auditory stimuli is to classify them as either "static" spatial definition (where different sounds are played through different sides of a headset, thus giving a player a sense of what is on their left or right even when their character is holding still) and "dynamic" spatial definition (where the volume of an unseen object or character is increased as the player approaches them and decreased as a player moves away, allowing the player to triangulate their location). Static definition is difficult to achieve if a player isn't wearing headphones or playing in an area with some sort of surround-sound system, while dynamic definition can be achieved without headphones. These configurations also aren't mutually exclusive, either; they can be combined to create an especially rich, immersive environment.

Now, what exactly is immersion, and why is it important? In their 2020 article, Bradley Kagan refers to games like "Guitar Hero" that focus on playing and recreating music as "musical simulators," and distinguishes them from games that provide greater "musical immersion" (games like "Crypt of the Necrodancer" and "Hollow Knight" that use music and sound cues to convey aspects of the in-game world or experience). Another way to explain immersion is as one professor of psychology expressed it: "In FPS (first-person perspective shooter) games, responses to misfortune are always in the nature of "I got killed" rather than "my in-game character was destroyed" (Grimshaw, 2011). An immersive experience may be the key to making video games a successful vehicle for treating PTSD and other conditions- providing patients with a fictitious sense of consequence, and thus incentivizing success. Immersion and detachment from the real world may help bypass some of the emotional discomfort of more traditional therapies. Indeed, Huang et al. (2017) found evidence that VR games (in the case of this experiment, the game "Beat Saber") can encourage people to push past the discomfort of

exercise to experience higher levels of physical activity through the medium of "exergaming." It isn't much of a stretch to think that this phenomenon could extend to emotional discomfort.

A form of therapy that relies on directional stimuli similar to the kind rhythm games employ is eye movement desensitization and reprocessing, also known as EMDR. During this treatment, after briefly exploring or recollecting a source of emotional trauma, the patient reflects on what comes to mind while they are exposed to "bilateral stimuli"- eye movements, taps on the body, or tones that alternate from one side to the other (Shapiro, 2012). Rather than requiring a patient to focus on the source of their trauma, this method requires the patient to barely visit the topic of their trauma. This makes it a useful option for those who cannot, or are unwilling to, revisit a vivid and detailed memory; in a 2022 lecture, Professor Kathryn Neely at the University of Virginia recounted how she underwent EMDR to reprocess a traumatic childhood experience that she could barely remember, allowing her to overcome her fear of dogs (undergraduate class lecture, September 20, 2022). R. Powell, a psychology student, expressed that he had found EMDR to be helpful in overcoming traumatic experiences from high school, including events that he was not "thinking about consciously very often" (personal communication, October 17, 2022). This form of therapy has not been without its own controversy, with some researchers at one point decrying it as pseudo-science and the dressing up of "a simple exposure therapy" (Perkins and Rouanzoin, 2001). Nevertheless, EMDR has gone on to become an accepted form of therapy with the American Medical Association, Inserm, and the National Institute for Clinical Excellence, as well as being recommended as a treatment by the International Society for Traumatic Stress Studies and the United States Department of Veteran Affairs (Shapiro, 2012, p. 194). There is little doubt that EMDR has reached some level of respectability in the field of

cognitive therapy, and the method's weathering of controversy provides some encouraging precedent that other emerging methods have the potential to endure such scrutiny and eventually become proven with mental healthcare practitioners.

Structuring Around Successes and Failures

According to the theory of "Engineering as Social Experimentation," an ethical framework put forward by Martin and Schinzinger (2010), engineers should be mindful of what their products might cause when released into the wider world. The theory holds that: 1) Every engineering project contains some elements of uncertainty, 2) The outcome of any engineering experiment is uncertain, 3) The success of engineering depends on gaining new knowledge, and finally 4) The ultimate design of a product's efficacy and efficiency is measured by how it functions in society, rather than how it functions in a lab, and therefore, monitoring of a product cannot be confined to a laboratory setting (Martin and Schinzinger, 2010). The authors emphasize the importance of preparing to address the unexpected, to envision possible shortcomings and disasters with all available scope of one's imagination, and to seek a form of informed consent from the end users of a product (that is to say, letting the population of your experiment understand and accept the risks of their participation through the use of your creation). The publication goes on to examine lessons learned from previous engineering disasters, such as the sinking of the Titanic and the explosion of the Challenger space shuttle. Finally, Martin and Schinzinger argue that regulation and legal codes should not be the driving force in taking precautions with the lives of consumers, as this leads to a mentality of "minimal compliance" rather than designing with a sense of pride and personal responsibility (2010, p.

100). Considering my goal is to explore the possibility of a new form of therapy, I feel like it's important that I visit lessons of the past- the data of previous "social experiments"- to shape my own technological proposal, both to design for success, and to anticipate potential pitfalls I, and engineers of the future, will need to navigate around. In particular, I want to examine how we might avoid being tempted into designing therapy rhythm games to fit a fad or a trend, rather than a genuine need.

Plenty of people who spent the late 2010s in America and western Europe will probably be familiar with the fidget spinner. This little plastic trinket, a spinning body mounted to a simple ball bearing and held by a central hub, was ostensibly a therapeutic tool for fidgeting behavior and ADHD. Between marketing, availability, and the popularity of fidget spinner tricks on social media, the toy became a cash cow that every child and adolescent simply had to have- within just a few months of the toy's release in 2017, tens of millions of units sold in the United States alone (Schechter et al., 2017). However, the toy rapidly gained infamy as their soft whirring and the social allure of showing off spinner tricks to their peers drew the attention of students away from their lessons. These spinners were eventually banned in classrooms across the United States and the United Kingdom because they proved to be more of a distraction than a solution (Javonillo, 2017). There's a lot of disagreement among both consumers and behavioral specialists as to whether fidget spinners were even an effective form of therapy, or whether they were just the result of a theory turning into a vehicle for profit. Dr. Katherine Isbister, a professor of Computational Media in the University of California, pointed out in an interview that stress balls, putty, and fidget cubes all performed well as fidget toys without creating the distracting spectacle that fidget spinners did (Javonillo, 2017). Dr. Scott Kollins, a clinical psychologist and professor

at Duke University, went one step further, theorizing that the popularity of fidget spinners stemmed from parents' desires for a simple solution to their children's attention problems, rather than any real benefits the devices may have provided (Schechter et al., 2017). As a result of this criticism and backlash, experts and non-experts alike seem to look back upon fidget spinners as a fad, rather than as helpful tools. This cash-grab, miracle-cure mentality can destroy the credibility of a good product, and the marketing and development of rhythm gam therapy should be mindful to avoid these temptations at all costs.

EMDR therapy can be used as a more encouraging example of engineering as social experimentation, not just because of the similar modalities between it and rhythm games, but also because it is a prime case of an unconventional therapy that managed to become accepted, despite initial pushback. EMDR produces results comparable to trauma-focused cognitive behavioral therapy, also called TF-CBT (Shapiro, 2012). However, TF-CBT, unlike EMDR, requires 1-2 hours daily of sensory exposure homework (Foa and Jaycox, 1999). Therefore, EMDR is arguably a more accessible form of therapy. With that being said, it's important that we not just imitate EMDR as it's currently being promoted, but rather, we should use the theories developing behind it to build our own methods and designs. Just like a scan of a document includes the defects and smudges on the original in any future copies, drawing inspiration from EMDR without due scrutiny could mean incorporating elements that are superfluous, or even detrimental, to the final product.

Some current practitioners of EMDR therapy have, as previously mentioned, begun replacing the eye movement aspect of the treatment with alternating, bilateral stimuli of taps or tones. While the eye movement method has been clinically tested and proven (van Veen et al.,

2019), these variant forms of the treatment are more experimental. Professor of clinical psychology, Dr. Marcel Van den Hout, among others, views these new methods with considerable skepticism (2012). This is due to a prominent theory behind why EMDR is effective: the working memory theory. Eye movement and mindful breathing exercises are both thought to tax working memory (van den Hout et al., 2011), while simply alternating sensory inputs without any engagement or decision-making on the part of the patient produces more dubious results. Why is this distinction important, you might ask? Human beings store recollections and knowledge in long-term memory, while current processes are handled in working memory. Long-term memory has a much greater capacity than working memory, and when multiple cognitive processes are being performed, they compete for the resources of active memory (Van den Hout and Engelhard, 2012). This may be how EMDR lessens the intensity of a negative memory; when the memory is recalled, it is processed in working memory, and during the therapy, tasks requiring eye movement cause the memory to compete for resources with the movement processing. As a result, the traumatic memory 'deflates' in how it is recalled and imagined, and once it is reconsolidated into long-term memory, the idea is that it will be stored in that diminished state (van den Hout and Engelhard, 2012). Dr. Klaus Oberauer, of the University of Zurich, asserted in 2019 that “working memory is by definition a form of attention” when he examined numerous studies and theories about how attention and working memory are connected. He also emphasized the importance working memory has on our ability to “build and maintain new representations that control our cognitive processes and “countermand our long-term knowledge” (Oberauer, 2019) - that is to say, changing our patterns of thought when an old memory or behavior proves to be an issue. Considering the already-strong evidence that

video games tax and encourage growth in the area of visuo-spatial attention (Green and Bavelier, 2012; Parong and Mayer, 2017), and considering the prevalence of working memory theory as the mechanism behind EMDR, it follows that we should consider incorporating the more time-tested elements of EMDR when designing a product for use in game therapy.

In some ways, the design of the infrastructure that might be repurposed into use for game therapy already helps to limit its potential to go the way of the fidget spinner. For a start, video games were not introduced as a product intended to treat traumas. They are seen as a form of entertainment. Game therapy is not the introduction of an entirely new product, but rather, the adaptation of an existing technology for a new purpose. Of course, one could argue that fidget spinners were also not an entirely new idea; cheap plastic toys have been around for decades, and it was simply a matter of patenting a trendy, unique design and slapping a “therapeutic” label on one to create a craze. However, in that description, we can find another distinction between our proposed technology and the fidget fad: fidget spinners were relatively cheap, accessible in almost every corner drug store, and easily stored in one’s pocket or bookbag. The scope of their disruption was due, in part, to their prevalence. In contrast, one does not simply haul their VR rig to school. Still, there’s another question that needs to be addressed here: should games designed for therapy be available on the consumer market? In theory, game therapy will be similar to EMDR in its administration, provided in a controlled and guided environment. There’s still a lot we don’t understand about the brain and the human psyche. Some experiments have demonstrated that EMDR reduces the intensity of any memory being reprocessed, regardless of whether the memory is positive or negative (van den Hout and Engelhard, 2012). Games that incidentally cause eye movement are unlikely to cause any real damage through accidental

reprocessing, but if a game is being marketed as therapeutic and consumers attempt to self-treat with only a limited understanding of the mechanics behind eye movement desensitization, we don't fully understand the psychological impact that could have. Therefore, in implementing this technology, we must push back against the "fad cure" pattern of behavior.

Designing for Purpose

How do we design products for rhythm game therapy that aren't just EMDR with a few bells and whistles? Building off of the theories of EMDR and working to make something that does what the existing therapy doesn't, what sets rhythm game therapy apart from EMDR is the more complex implementation of audio cues by video games. These games can build upon the root mechanism of working memory theory to allow their efficacy. The game should force the player to make decisions and take actions that employ eye movement or full-body movement. While beeps and taps on their own may have questionable effectiveness in EMDR, that is less because touch and hearing are less valid senses than sight, and more because the methods currently being employed in EMDR therapy do not tax working memory (van den Hout and Engelhard, 2012). With proper application, the other senses can have the same, potent effects. There is actually strong evidence suggesting that sight and hearing use the same or similar neurological infrastructure (Fritz et al., 2007), and some evidence emerged just this year through direct experimentation that rhythmic motor exercises can be used to improve working memory (Ghaffari et al., 2022). Therefore, there is merit to rhythm game therapy versus EMDR, as the complex directional sound cues involved in immersive rhythm games play a key part in the decision-making of the player.

A good baseline model for an enjoyable game that employs bilateral stimuli and taxes decision-making memory is the VR game *Beat Saber*. In this 2018 game, you use virtual lightsabers, projected from hand-held controllers, to slash at note blocks that fly at you to the rhythm of the music. These note blocks are color-coded, indicating whether they should be interacted with by the left- or right-hand saber. That being said, levels have an alternative one-handed playstyle, meaning that this gameplay format is not exclusionary for people with mobility impairments on one side of their body. *Beat Saber* has already been part of experiments which demonstrated marked improvement in the spatial attention spans of its test group (Flores-Gallegos et al., 2022). However, I do not believe that *Beat Saber* itself is entirely ideal for therapeutic use, especially if we are focusing on cases of PTSD. Games designed for therapeutic purposes must avoid known triggers of the conditions they seek to treat. For example, PTSD is both a prevalent condition and one that has a broad spectrum of causes (Lavin, 2012). These causes include, but are not limited to, domestic violence, sexual violence, combat, natural disasters, and manmade disasters such as vehicle crashes (Lavin, 2012). For this reason, games designed to help a patient process PTSD should avoid references and depictions of violence, loud noises reminiscent of crashes or explosions, or references and depictions of the aforementioned disasters. Driving and flying simulations are probably not a good idea. Rapidly flashing lights should also be omitted, as this would make game therapy less accessible to individuals with conditions such as epilepsy. *Beat Saber*, while a good example of game mechanics, has several aesthetic touches that makes it less than ideal for the treatment of vulnerable parties. The game features strobing lights in the backdrop of the levels, harsh industrial-techno music, and in the case of some tracks, sound effects reminiscent of rapid-fire shots. Its gameplay can also be

physically intense, encouraging physician exertion to the point of inducing heavy sweating, which is something that may not be ideal for therapy of this type; in an interview, R. Powell (personal communication, October 17, 2022) expressed how the experience was “tranquil and almost like hypnosis.” He further expressed his opinion that “a treatment using EMDR as a model shouldn’t be high intensity. It should be sort of relaxing, to allow a person to go into” what he called “a state of controlled auto-pilot.” Taking his input into consideration, we can conclude that games designed for therapeutic purposes should not be as physically rigorous as *Beat Saber*, but rather, the experience should be conducive to entering a more meditative state.

In terms of considering whether VR or conventional games should be used, you should consider the phenomenon of “sim sickness” experienced by some players- while most players experience no lasting effects after using VR, the use of this technology can occasionally lead to disorientation for up to hours afterwards (Huang et al., 2017). That being said, the immersive nature of VR could also prove a helpful tool in making this treatment more effective. Further evidence would need to be acquired through future testing to determine which format has the better balance of benefits and drawbacks. Finally, and most importantly, this technology should not be designed as, nor marketed as, do-it-yourself therapy. Even if there is a possibility that game therapy will prove to be simple enough to use without guidance from therapists, we want to avoid going the way of the fidget spinner, especially before this new method has had time to be tested and proven.

While Table 1 is not an exhaustive or even extensive analysis of features that developers might consider when designing a product for game therapy, it summarizes some of the key points we’ve explored here, and elaborates on a few of them a little further.

Table 1: A Brief Overview of Features and Elements To Be Considered in Game Therapy Design (Created by Author)

Design Element	Recommended /Not	Rationale
Bi-lateral sounds/music	Recommended	Bi-lateral decision-making is reminiscent of EMDR, which has shown promising results. Specifically, alternating stimuli tied to decision-making may have similar cognitive effects to decision-making tied to eye movement. Further investigation is needed, but the evidence is favorable.
Rhythmic elements	Recommended	Recent experiments suggest rhythmic motor exercises and working memory improvements are connected.
FPS (first-person) elements	varies	While a first-person perspective can aid immersion, this may cause sim sickness, and the wrong simulated scenario could trigger a patient's past traumas. Use with discretion.
Portability	(mostly) Not Recommended	This should not be marketed as a fad, do-it-yourself cure. Games developed for this purpose should not be marketed as such. Having a modified "commercial" version of a game used for therapy might help make it more financially feasible, but in that case, it should be marketed as purely entertainment, with the therapeutic version requiring the supervision of a counselor. Game therapy should not require its own proprietary equipment, as that goes too far in the other direction, making it prohibitive for smaller practices to acquire.
Moving points of focus	Recommended	Eye movement has proven to be a key part of EMDR, with the theory behind it being that controlling eye movement to perform tasks taxes working memory. If this therapy wants to operate on the same theories, eye movement should be encouraged.
Heavy themes (violence, sexuality, drug use)	Not Recommended	While these themes can be engaging in commercial games, the patients in this therapy are not those who will likely find comfort or interest in confronting them. Our model therapy does not focus on deep reflection of a traumatic subject, but rather, encourages the diminishing

		and reprocessing of that memory. Therefore, these potential PTSD triggers should be avoided.
Flashing lights	Not Recommended	Though flashing lights can add a layer of excitement and intensity to commercial video games, they are a potential trigger for both PTSD episodes and epilepsy. Furthermore, based on interviews, therapy rhythm games should be limited in their intensity.
Driving/flying simulators	(mostly) Not Recommended	While some patients might find these simulators relaxing, the experience of being in a plane/car may be a trigger for PTSD in others. Though variations on this therapy could use these simulations, this format should be avoided when creating a common design for testing.
Colorful/engaging visuals	Recommended	Though not necessarily a key part of the therapy, colorful and engaging visuals can immerse the player, holding their attention and encouraging them to engage further with the therapy.
VR support	varies	VR headsets can cause disorientation and nausea to some individuals, which would make a game that relies on VR less accessible. On the other hand, VR can create highly immersive experiences, which can encourage the patient to engage more in the therapy. It's unclear whether the benefits or the drawbacks are greater in this case, and this question merits further exploration.

Finale

So, can rhythm game therapy find its place in the world of psychological therapy? It's a novel idea, and an unusual one, but it isn't without its foundations. Other unconventional therapies, such as EMDR, have weathered controversy and skepticism to be accepted and better understood, and this design solution benefits from what we've learned as the result of several other studies. We can build a foundation on the theory of working memory, and even if this theory is shaken or disproven in the future, I believe the ideas behind it are significant enough

that whatever emerges in its place could still justify the reasoning behind rhythm game therapy. We've looked at evidence from over half a decade of studies showing strong evidence that video games can be used as a teaching tool and a method of attention improvement. Martin and Schinzinger's framework for engineering as social experimentation has helped guide our imaginations of what problems this technology might experience, in particular by using the results of previous social experiments to guard against the temptations of creating fad medicine to generate a quick buck, while also reminding us that not even accepted therapies are without flaw or scrutiny. Finally, we've considered ways to help this therapy stay true to its purpose, focusing on its efficacy and our care for potential patients, while avoiding features that might harm patients or be detrimental to the therapy. While drawing on the resources of working memory through sound-based decision-making, rhythm games still exist in a visual medium, meaning that they also encourage eye movement in the player. It's possible that this form of therapy could desensitize and reprocess memories more efficiently than EMDR, given the high demand on working memory, though it's still too early to say for sure. The next step in this process, should the idea be found acceptable by others, is the design and testing of prototypes. From there, researchers should measure the efficacy and drawbacks, and make adjustments to both improve the efficacy and decrease any discovered drawbacks.

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