

Applying the Diffusion of Innovation Model to Understand Adoption Patterns for Virtual Reality Exposure Therapy (VRET) in Clinical Psychology

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On my honor as a University student, I have neither given nor received unauthorized aid on this assignment as defined by the Honor Guidelines for Thesis-Related Assignments

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I. Introduction

Mental health disorders affect one in five adults and are among the leading causes of ill-health and disability worldwide. Although treatments are available, nearly two-thirds of people with known disorders never seek help from a mental health professional (*Mental Health By the Numbers*, 2019). Anxiety disorders are the most common mental illness in the United States and are highly treatable, yet only 37% of those suffering actually receive treatment (*Facts & Statistics*, 2018). Typical treatments for anxiety disorders include medication, cognitive behavioral therapy (CBT), and self-care techniques such as meditation. Evidence has demonstrated that exposure therapy, a type of CBT in which a therapist systematically exposes a patient to a feared object or situation until they overcome their distress, can be incredibly effective in mitigating symptoms of a variety of anxiety-related disorders (Norton and Price, 2007).

Virtual reality (VR) has been implemented in exposure therapy because the technology can generate realistic and compelling simulations of real-life anxiety inducing scenarios. The combination of these methods is known as virtual reality exposure therapy (VRET), which permits individualized, gradual, controlled, immersive experiences that are easy for therapists to provide and often more acceptable to patients than imaginal exposure (Boeldt et al., 2019). Despite strong evidence of effectiveness, VRET is an underutilized treatment for anxiety disorders at a time when effective treatment for anxiety is greatly needed. While the utility of VRET in psychology has been validated and its prevalence in the field has been gauged, the diffusion trajectory of the technology into the field has not been thoroughly studied.

Everett Rogers' Diffusion of Innovation (DOI) theory aims to explain how a technology gains momentum and diffuses through a population or social system over time (LaMorte, 2019). Although other research has evaluated VR in psychology, DOI theory has yet to be applied to

this topic to understand adoption patterns and the corresponding “diffusion” status into the field. Through applying DOI theory, this paper aims to identify the groups that belong to each of Rogers’ specified adopter categories to grasp the current state and future trajectory of VRET diffusion in psychology. With an understanding of the diffusion path, innovators, investors and individuals interested in the psychological health field can assess if VRET may be the future of clinical psychology and deem if investing time and resources into advancing this treatment technology is worthwhile. Further, this insight will inform mental health providers if training in this method is necessary such that they could offer VRET to patients, and patients could learn if VRET may be part of their disorder management in the future.

II. Background

VRET has demonstrated promise in treating a variety of psychological disorders such as anxiety, phobias, post-traumatic stress disorder (PTSD), depression, bipolar disorder and more (Krijn et al., 2004, p.259; Oprea et al., 2012, p.90). VRET treatment sessions might involve a person afraid of water immersed in a virtual simulation where he or she must walk over a bridge, or a person afraid of flying virtually participating in a scene “inside” of an airplane. The idea is that repeated exposure to VR sessions in which the patient emerges unscathed from the experience enables him or her to overcome the particular fear or phobia (Exposure Therapy—Type of Therapy, n.d.; Why Virtual Reality Is Set to Transform Mental Health Treatment, n.d.).

Modifying the need for routine therapy sessions and daily medications could greatly simplify disorder management for patients and providers. From the perspective of clinicians who provide cognitive behavioral therapy and psychiatrists who prescribe medication, VRET has the capacity to alter or reduce the need for their services as patients could schedule sessions at their convenience and discretion. Incorporating VR in therapy can increase the ease, acceptability, and

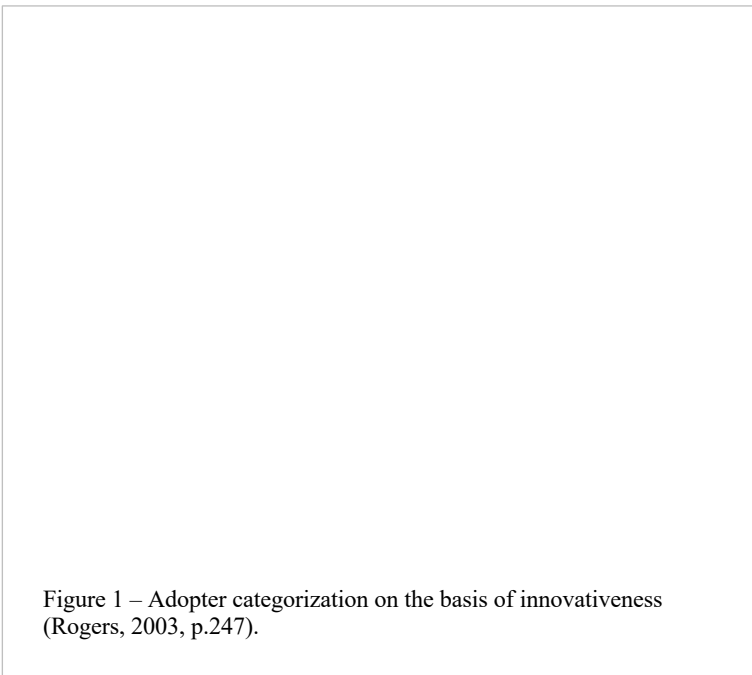
effectiveness of treatment for anxiety (Carl et al., 2019). Studies have demonstrated that in many cases, the addition of VRET has actually improved patient outcomes and responses to treatments (Boeldt et al., 2019). However, there are still many obstacles to clinical adoption and implementation and as a result, VRET has not been fully embraced in the clinical psychology field.

III. The Diffusion of Innovation Model

Healthcare is continuously evolving due to the abundance of research in the field and resultant biomedical innovations. However, substantiating the efficacy of a new technology is not sufficient to guarantee public approval and societal integration, and adoption of healthcare inventions is not inevitable. There are numerous factors that suggest why medical technologies may fail to infiltrate the healthcare system. It is important to identify the factors and societal patterns that encourage, versus prevent, diffusion of medical innovation such that products can be successfully transferred from research laboratories to routine clinical practice. Many theories try to explain these factors, but Everett Rogers' theoretical framework is one of the most proven approaches to innovation diffusion research and is incredibly informative in determining the adoption of specific clinical behaviors (Sanson-Fisher, 2004).

Rogers' DOI theory seeks to explain how, why, and at what rate new ideas and technologies spread. The theory argues that diffusion is "the process by which an innovation is communicated over time among the participants in a social system" and has four main elements that influence the spread of a new idea: characteristics of the innovation itself, the social system, communication channels, and time (Rogers, 2003, p. 11). There are stages by which people adopt an innovation and some people are more apt to do so than others, so adoption of a new idea or product is a process and does not happen instantaneously (LaMorte, 2019).

Rogers proposes that there are five categories of adopters, which are classifications of the members of a social system on the basis of innovativeness. The categories of adopters are: innovators, early adopters, early majority, late majority, and laggards (Rogers, 2003, p.22). Figure 1 illustrates the bell curve adopter distribution including the approximate percentages of individuals in each, as well as the corresponding of market reach associated with each succeeding group. Figure 2 reports the characteristics of each adopter category.



Adopter Category	Characteristics
Innovators	Uses innovation first, interested in new ideas, willing to take risks
Early Adopters	Opinion leaders, try the innovation then confirm or reject its viability, communicate decision with social network
Early Majority	Adopt new ideas before the average person, need evidence that innovation works, aid in mainstreaming innovation
Late Majority	Adopts innovation once in widespread use, skeptical of change
Laggards	Last individuals to adopt, may be forced to do so once old products phase out, conservative and bound by tradition

Figure 2 – Characteristics of adopter categories (Rogers, 2003, p.248-251; LaMorte, 2019).

It is important to note that emergence of all adopter categories is not inevitable and only occurs when an innovation is embraced by a population over time. If diffusion does happen, the innovation will eventually reach “critical mass” within the adoption curve, meaning there are sufficient adopters to ensure the innovation is self-sustaining and creates future growth (Rogers, 2003). Innovations that completely diffuse will follow the s-shaped curve and reach 100% market share as shown in Figure 1. In some cases, diffusion of a particular innovation might “fail,” which means that it does not achieve 100% adoption due to weaknesses, competition, a

lack of awareness or another reason. Incomplete adoption and non-adoption do not form this adopter classification and only adopters of successful innovations generate the curve depicted in Figure 1 (Rogers, 2003). However, failed diffusion does not mean that the technology was adopted by no one, a failed diffusion might be widely adopted within certain clusters but fail to make a widespread impact (LaMorte, 2019).

IV. Related Work: Diffusion of Innovation & Virtual Reality

Several studies have attempted to analyze the adoption of VR technology more broadly through the lens of Rogers' Diffusion of Innovation theory. While these works investigate VR for a range of applications and not specifically VRET in psychology, they provide insights that inform the degree of integration of the technology into society as a whole. Prior research suggests that even if VR has the potential to save time and money, it does not serve as a competitive alternative to existing solutions if the technology is not adequately developed or is accompanied by high operating costs. However, with the emergence of new technologies that yield more benefits and technological advancements that decrease expenses, comes substantially more adopters (Ellman & Tiainen, 2019).

Researchers agree that the diffusion trajectory of VR is unpredictable and it is difficult to apply Rogers' model at this stage because VR technology may not be sufficiently developed and does not have obvious market potential so extensive diffusion is not taking place among consumers (Krohner 2016; Regrebsubla, 2016). There is also a false perception of VR ubiquity while the majority of individuals are uninformed about the technology and unmotivated to adopt it, so it is challenging to determine the "Tipping Point" per Rogers' theory to forecast adoption

(Krohner 2016). For these reasons, it is difficult to discern the state of VR diffusion, or if the innovation will ultimately follow Rogers' characteristic normal distribution adoption pattern.

Although many studies apply the DOI theory to VR, they evaluate the diffusion of the technology in a general sense rather than within the context of psychology. They reveal that the DOI model may not be suited for widespread VR diffusion analysis, but has the potential to inform adoption of a focused application of the technology such as VRET in the realm of clinical psychology.

V. Applying the Diffusion of Innovation to VRET

A. Innovation

Rogers proposes that there are certain attributes of an innovation that influence the associated rate of adoption. These include the degree to which an innovation is seen as better than the entity it replaces, the compatibility of the innovation with the needs of potential adopters, the complexity of the innovation, the extent to which the innovation can be trialed before commitment to adoption, and the extent to which the innovation provides observable results (Rogers, 2003, p. 232).

VRET can be understood as an altered form of exposure therapy in which VR is integrated with “real-time computer graphics, body tracking devices, visual displays, and other sensory input devices to immerse patients in a computer-generated virtual environment” (Krijn et al., 2004, p.259). A few issues that impede the common use of VRET include the lack of standardization of VR hardware and software, the inability of providers to customize virtual

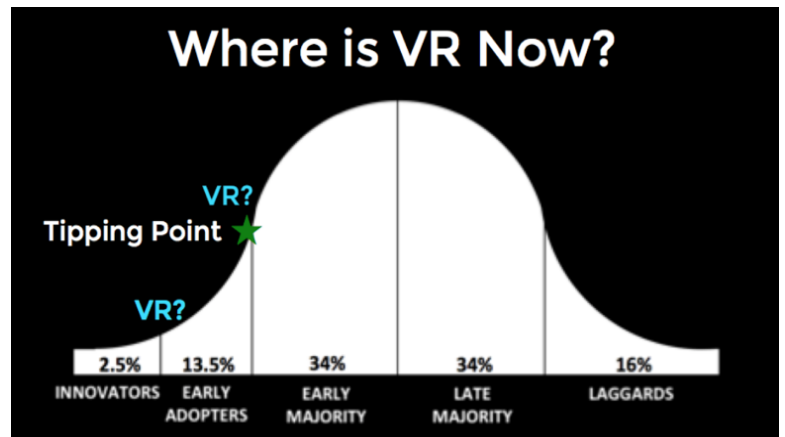


Figure 3 – The “Tipping Point” is the stage between early adoption and early majority when 15–30% of society has accepted and begun using the innovation (Krohner, 2016).

environments for specific purposes, the dearth of standardized protocols for the research community, the astronomical costs associated with designing and testing VR technologies in clinical settings, and malfunctioning/nonintuitive user interfaces that require frequent maintenance (Riva, 2009, p.340). VRET technology encompasses many hardware devices and software applications for which improved versions are developed and released at different rates, so the diffusion trajectory of VRET may be atypical (Krohner 2016; Regrebsubla, 2016). Additionally, psychological health providers may be unaware of the technology's existence and effectiveness, unable to purchase the required equipment to provide it for patients, or unwilling to modify their customary treatment methods to incorporate this modern therapy. Similarly, patients may be unfamiliar with VRET as a treatment option, unaware of the availability of VRET through their provider, or hesitant to alter their trusted treatment routine. For these reasons, VRET in its current state isn't ubiquitous in clinical psychology practice and may be ill-suited for successful diffusion.

B. Social System

Diffusion of innovations takes place in a social system, which Rogers defines as “a set of interrelated units engaged in joint problem solving to accomplish a common goal” (Rogers, 2003, p.23). In DOI theory, members of the social system include individuals belonging to each of the five adopter categories who will use the innovation (Rogers, 2003, p.5).

According to Rogers' DOI theory, *Innovators* are the first 2.5% of the population to embrace a novel idea. In the mid-1990s, psychologists began to pilot VRET technology through clinical trials to treat psychological health conditions (Metz, 2017; Winerman, 2005). In 1995, psychologist Barbara Rothbaum, PhD and computer scientist Larry Hodges, PhD, published the first study revealing that VR therapy helped patients overcome a fear of heights. The next year,

psychologists Albert Carlin, PhD and Hunter Hoffman, PhD, published a study that demonstrated that VR could help patients with a fear of spiders (*Why Virtual Reality Is Set to Transform Mental Health Treatment*, n.d.). In 1996, Dr. Rothbaum and her colleagues established a company called Virtually Better Inc. (VBI) to commercially develop and distribute their VR software and equipment to clinicians (Winerman, 2005). Rothbaum, Hodges, Carlin, and Hoffman are the first documented individuals who provided VRET to patients, and would thus be categorized as *Innovators* according to Rogers' theory. Since the establishment of VBI in 1996, the company has evolved and similar companies have been founded such as Psious in 2014 and Limbix in 2016 (Senson, 2016; Metz, 2017).

Psious and Limbix offer technologies that retail to individuals for self-help purposes rather than limiting their products to professionals (Metz, 2017; Huff, 2020). Psious is a Spanish start-up founded by Xavier Palomer that introduced the first all-in-one VR platform for therapists and mental health professionals ("BHH Interviews," 2019; Virtual reality kit for therapists," 2020). Limbix, founded by Jon Sockell, offers a comparable kit package that includes a customized VR headset, tablet, docking station, and complete content library (Metz, 2017; Sockell, 2017; *Limbix VR Kit*, 2020). In contrast to VBI that only designs products for therapists, both Psious and Limbix offer multiple kits versions to meet the differing needs of patients and providers. Although they weren't the first to use VR in a mental health setting, Palomer and Sockell would also be considered *Innovators* in the eyes of Rogers. These individuals have adapted, combined and expanded VR technologies to serve the needs of mental health providers and patients to ultimately facilitate the integration of VRET into psychology.

Since initial experimentation, VRET has been trialed and implemented by mental health providers in clinical settings. These individuals are deemed *Early Adopters* per Rogers'

Diffusion of Innovation theory, as they are among the first to test the innovation and share their experiences with their networks to communicate its existence and efficacy. Dr. Dawn Jewell is one of the first psychologists to test Limbix services and claims that VR “provides exposure in a way that patients feel safe,” by enabling the patient and provider to travel to a location together while simultaneously permitting the patient to communicate how he or she is feeling (Metz, 2017). Another psychologist, Dr. Pamela Poston, has had success implementing the Limbix Teleporter to travel with patients who suffer from phobias or PTSD to feared locations or locations in which traumatic events have occurred (Sockell, 2019). Dr. Sean Sullivan, the Director of Psychology for Limbix, wrote that Limbix technology has significantly enhanced his practice and highly recommends that other providers explore the value of incorporating VR in their own practices (Sullivan, 2017). These individuals are some of the first to implement VR products developed by companies specifically for use in clinical psychology.

In addition to the individuals who have purchased kits from specialized companies, some providers have independently invested in VR equipment to offer VRET. For example, Dr. Mark Wiederhold, president of Virtual Reality Medical Center in California, has developed his own VRET treatment protocols to treat anxiety and phobias in patients (Collier, 2008). Other individuals have implemented VRET in research or academic settings to study its effectiveness. Dr. Patrick Bordnick, who was previously the Director of the Virtual Reality Clinical Research Lab at the University of Houston Graduate College of Social Work, helped develop virtual environments for substance abuse and other behavioral disorders (*Patrick Bordnick, 2020*). In his current role as Dean of the Tulane University School of Social Work, Dr. Bordnick is studying VRET for addiction (Kuchler, 2018).

Though many psychologists have begun to implement VR technology for VRET, the treatment has not permeated the field and does not exist as a standard of care. It will be essential for *Early Adopters* to adequately communicate their success with VRET in order for it to become acknowledged and implemented in the field of psychology.

C. Communication Channels

Evidence has demonstrated that for the permeation of a novel technology, adopters must be willing and motivated to share their experiences with their social networks (Rogers, 2003). Channels of communication used to convey information about clinical practice include research publications, databases, the mass media, lectures, workshops, videos, podcasts and direct communication with experienced individuals (Sanson-Fisher, 2004). In the case of VRET, there are platforms for users to engage and share, but they have yet to facilitate pervasive diffusion of the technology in psychology.

Limbix and Psious regularly maintain blogs that feature product reviews by clinicians and direct interviews with providers regarding implementation of VRET services in practice. These blogs serve as forums for therapists to document and share their familiarities with VRET kits and communicate product utility accordingly to their peers. For example, Dr. Gerard Finnemore, a clinical psychologist from South Africa, learned about VRET from a colleague, which prompted him to invest in the services offered by Psious. His experience and praise for the ease and efficacy of Psious VRET products were then then published on the Psious blog for mental health patients, professionals and the general public to read (Gabriella, 2018).

Other VRET providers promote the use of the therapy tool to peers through interviews, podcasts, webinars and classrooms. For example, the *Voices of VR Podcast* conducts and publishes interviews with individuals driving the resurgence of VR, many of which converse

with users and advocates of VRET (Bye, 2020). Additionally, Limbix's informational video webinars feature professionals who discuss their experiences with VRET, answer commonly asked questions, and advocate for the benefits of VR therapy (Sockell & McMahon, 2019). Finally, Dr. Bordnick of Tulane University is currently training his students how to integrate VRET into practice (Kuchler, 2018).

The most effective communication strategy, however, is face-to-face exchange when there is a high degree of professional resemblance between the individual attempting to introduce the innovation and the recipient, such as psychologist to psychologist (Sanson-Fisher, 2004). It will be essential to orchestrate additional face-to-face interactions among mental health providers to establish widespread acknowledgement of VRET and attract future adopters.

D. Time

Rogers argues that the innovation-diffusion process includes a time dimension that informs the rate of acceptance and adoption of the innovation (Rogers, 2003). Although the concept of VRET and necessary technology have long been available and distinct *Innovators* and *Early Adopters* have emerged, the majority of providers are still unaware of its existence. Psychologists surveyed on VRET knowledge and usage and the number of VRET publications in recent years demonstrates that the technology is still in the beginning stages of diffusion into psychology.

A recent study was conducted in which visitors to the 46th Congress European Association of Behavioral and Cognitive Therapies in Stockholm, Sweden were recruited and surveyed with the sole inclusion criteria of practicing CBT to some degree (Lindner et al., 2019). Results indicated that 86% of participants reported no experience with VR in a clinical setting, only 3% reported frequent use, and the remaining 10% reported occasional use (Lindner et al.,

2019). Further, average knowledge of VRET was rated 3.37 on a 0–10 scale (10 being the highest) and nearly a quarter of participants (23%) reported no knowledge of VRET at all (Lindner et al., 2019). The study reveals the small degree of awareness and use of the technology in the field, which supports that VRET is still in the early stages of adoption by providers for mental health treatment.

Data also demonstrates that the number of VRET publications per year in the medical and psychological health fields has been steadily increasing and doesn't appear to have peaked or plateaued. Figure 4 depicts the number of VRET publications by year on PubMed, a database of biomedical and life sciences literature, and the number of VR publications by year on APA

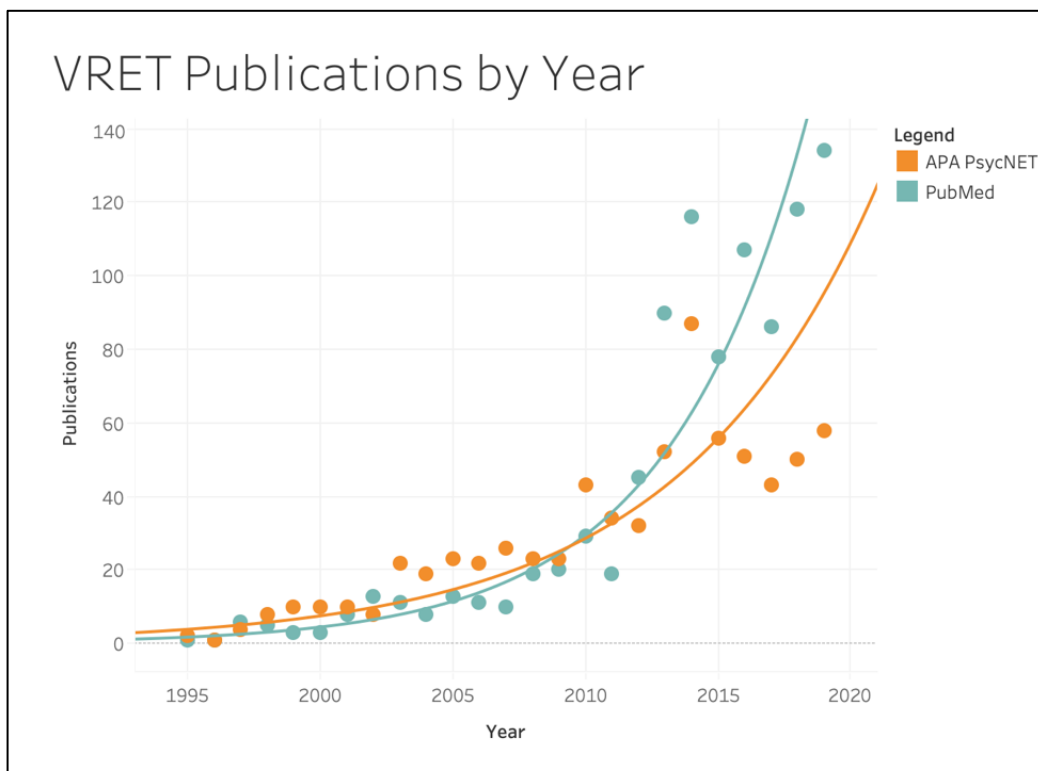


Figure 4 – Number of publications on VRET by year from 1995 to 2019. Publication data extracted from PubMed and APA PsycNET.

PsycNet, the most popular psychological health database. Overlaid trendlines indicate that exponential growth has occurred in the last 24 years and forecasts that more VRET publications will arise in the coming years if these trends persist. This further supports the idea that VRET is

early in the diffusion trajectory in the realm of clinical psychology and has the potential to follow Rogers' DOI bell curve if adoption patterns continue.

While there are clear actors in the *Innovators* and *Early Adopter* categories, the *Early Majority* category doesn't seem to have appeared yet in society. As indicated in Figure 2, one of the defining characteristics of the *Early Majority* is that they need evidence an innovation works in order to accept and ultimately adopt it. It will be necessary for members of the first two adopter categories to adequately communicate with their peers and social network such that the *Early Majority* and subsequent adopter groups can emerge.

VI. Discussion

VR and exposure therapy have been around for decades and the combination as VRET has repeatedly been proven successful for numerous anxiety disorders. Many providers know of VRET's efficacy, but practices have only begun to implement it, few companies have privatized it, and it has not become a standard treatment. Based on the timeframe for which VRET has been a known and available tool for psychological health as well as the number of publications over time (shown in Figure 4), it is evident that VRET adoption in clinical psychology is either characterized by a slow early adoption phase or has reached critical mass.

The idea that VRET in psychology may simply experience a gradual initial diffusion pattern is supported by the fact that the pace of new technology adoption by therapists is generally slow. Behavioral health interventions historically emphasize face-to-face delivery relying on human judgment and assessment, and the current communication channels in place for VRET do not exploit this method (Boeldt et al., 2019). This might explain why VRET has not experienced rapid or widespread diffusion in the field of psychology and might not ever saturate the field. Alternatively, it is possible that VRET has reached critical mass, meaning the

technology has achieved its maximum number of adopters and will have a diminished peak level of adoption according to Rogers' theory. VRET has arguably been around for long enough that providers in the field should know it exists and have either chosen to opt in or out of use. VRET may be classified as an invention that has "failed to diffuse" effectively into clinical psychology because it will likely never achieve 100% adoption.

The coming years will be crucial to monitor and document the spread of VRET in clinical psychology. It will be important to measure the knowledge and usage level of the therapy tool among psychologists in order to determine if user adoption is increasing, or critical mass has been reached. Understanding the trajectory of VRET is essential for providers and patients in the field of clinical psychology, as well as the companies, investors, and innovators devoted to furthering the incorporated technologies.

VII. Conclusion

VRET is a proven method for treating a breadth of psychological diagnoses but has not become regularly prescribed at a time when mental health disorders are common and accessible treatment is needed. Studies have analyzed the integration of VRET in psychology and found that adoption among mental health professionals has been slow and familiarity with the technology is limited. Rogers' DOI theory was applied to investigate why user acceptance might be slow through exploration of the following elements: the innovation, communication channels, social system, and time. Review of prior work reveals that DOI may not be the optimal framework to understand the past and future adoption trajectory for widespread use of VR, but might be valuable for understanding a niche application such as VRET in clinical psychology. Examination of each of these elements suggests that slow VRET acceptance might be because the innovation is not well understood by potential users and existing communication channels are

not sufficiently developed. While decades have passed since the first documented use of VRET, continued observation of VRET implementation over time and analysis of the attitudes and perspectives of prospective adopters will be vital to discern the degree of diffusion and fate of VRET in clinical psychology.

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