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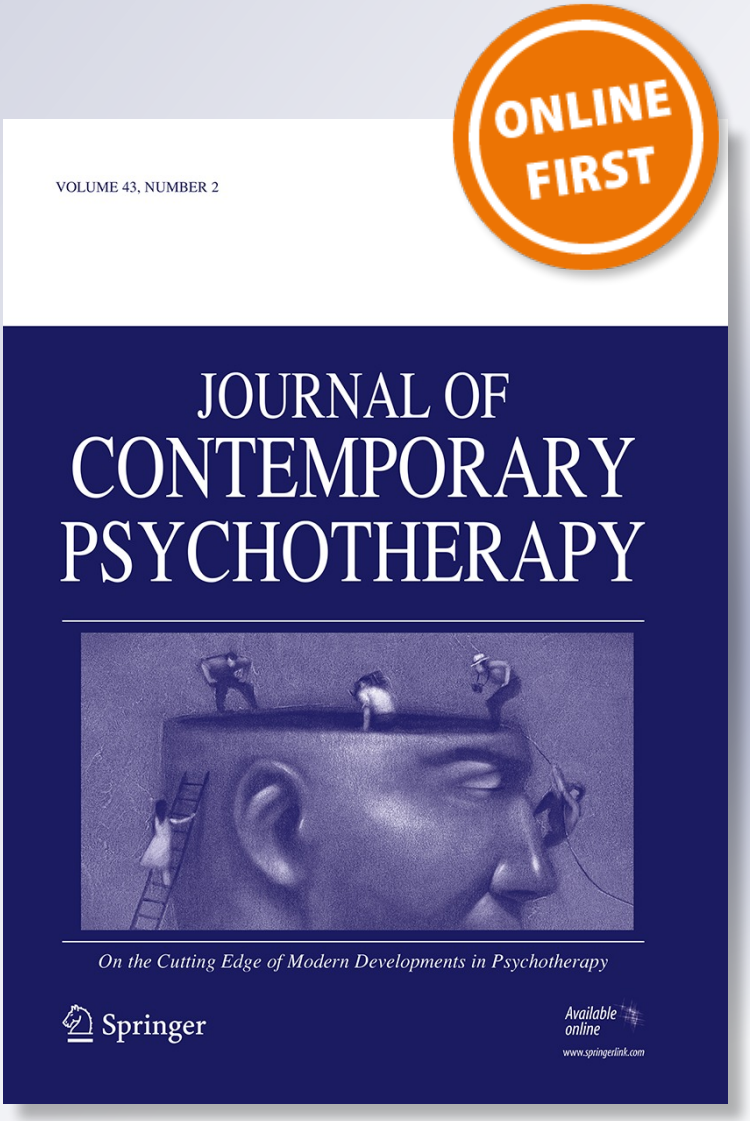
Journal of Contemporary Psychotherapy
On the Cutting Edge of Modern Developments in Psychotherapy

ISSN 0022-0116

J Contemp Psychother
DOI 10.1007/s10879-013-9238-8



Springer

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ORIGINAL PAPER

Innovation in Technology-Aided Psychotherapy Through Human Factors/Ergonomics: Toward a Collaborative Approach

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Abstract Technologies are being used increasingly to aid psychotherapy and are becoming an integral part of mental health treatment. Although prior studies compared technology-aided psychotherapy (TAP) to traditional treatments, there are insufficient studies of the impact that specific design parameters and use of the technologies may have on the client and therapist, and treatment outcomes. This requires an understanding of human–technology interaction, which is the focus of the field of Human Factors and Ergonomics (HF/E). The goal of this article is to raise awareness of the importance of the human–technology interaction in TAP, and to foster collaborations between psychotherapists and HF/E professionals. Toward these aims, this article examines the implications of findings in HF/E for the use of technologies (videoconferencing, text-based communication, and virtual environments) in psychotherapy. It is suggested that the manner in which technologies are designed and used may have important effects on the therapeutic alliance and treatment outcomes, and in some cases (side effects of virtual reality) the health and safety of the client. Future research should examine effects of specific design factors on treatment including variables such as the visibility of gestures and degree of eye contact during videoconferencing, response delays during text-messaging, and presence and adverse effects when using virtual environments. Studies that compare TAP to traditional methods should report as much detail as possible about the human–technology interaction. It is essential that psychotherapists and HF/E professionals conduct research collaboratively to develop effective and innovative technologies and, ultimately, design principles for TAP.

Keywords Psychotherapy · Telemental health · Telehealth · Human factors · Ergonomics · Human–computer interaction

Introduction

Increasingly, technologies such as videoconferencing, Internet (e-mail, chat rooms), phones, and virtual environments, are being used to diagnose and monitor clients, deliver treatment, and help clients adhere to therapy (Clough and Casey 2011a, b; García-Linzana and Muñoz-Mayorga 2010). It is anticipated that the Internet and other digital tools will become an integral part of mental health services (Bray 2010).

The increasing use of technologies in psychotherapy has led researchers to examine whether technology-aided psychotherapy (TAP) is as effective as traditional methods. Typically, studies achieve this by first examining whether clients improve when treatment is delivered with the aid of a technology, and then by examining whether the improvement is comparable to that achieved with traditional treatment. Fewer studies try to identify the technological variables that might influence the effectiveness of TAP, and studies typically do not provide sufficient detail to allow such analyses (Krijn et al. 2004; Parsons and Rizzo 2008). Results of various studies suggest that therapy mediated by technologies such as videoconferencing, Internet, phones, and virtual reality can be as effective as traditional face-to-face therapy for a variety of disorders (Brenes et al. 2011; Emmelkamp 2005; Nelson et al. 2003; Rothbaum et al. 2006). However, it has been concluded on

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Published online: 19 June 2013

the basis of literature reviews and meta-analyses that the quantity and quality of the evidence is limited, and the magnitude of effectiveness varies and depends on the disorder being treated (Backhaus et al. 2012; Bee et al. 2008; García-Linzana and Muñoz-Mayorga 2010; Meyerbröker and Emmelkamp 2010; Opris et al. 2012; Parsons and Rizzo 2008). Limitations include small sample sizes, nonstandardized measures, lack of control groups and lack of random assignment to conditions.

Human–Technology Interaction

It is argued here that another critical limitation of previous studies of TAP is insufficient examination of the potential impact of the particular design and use of the technologies on the client, therapist, and treatment efficacy. This is important because it is well established that the manner in which a technology is designed and used can influence an individual's cognitive, perceptual, motor, emotional, physical, and social responses (Hancock et al. 2005; Wickens et al. 1998). Technologies that are poorly designed or are not used properly can result in confusion, frustration, ineffective performance, harm, and reluctance to use the technology.

To develop effective and innovative technologies for TAP, it is necessary to understand the limitations and capabilities of human behavior and incorporate this understanding into the design and use of the technologies. The study of the human–technology system is the focus of the scientific discipline known as engineering psychology, applied experimental psychology, or human factors and ergonomics (HF/E), the term used here. HF/E has been credited with improving safety and performance in domains such as driving, aviation, and health care (Cooke and Durso 2008). Despite sporadic discussions of the importance of HF/E in mental health applications over the past four decades (Jerome and Zaylor, 2000; Johnson et al. 1981; Rappaport 1970), the focus of HF/E studies of health care has been on physical health rather on than mental health (DeLucia and Harold 2011). It is essential that psychotherapists and HF/E professionals collaborate to develop effective and innovative technologies.

The development of design principles that are specific to the context of TAP requires research that measures the responses of the client and therapist to specific design configurations, and treatment outcomes. Although some guidelines and principles for TAP have been published (Doherty et al. 2010; Nelson et al. 2011; Yellowlees et al. 2010), most of the guidelines lack the information needed to allow clinicians or HF/E professionals to choose the optimal design configuration or to evaluate the potential contribution of different design parameters to treatment efficacy and client satisfaction. Many guidelines focus on issues such as privacy, confidentiality, ethics, clinical procedures, competencies, and regulations rather than on human–technology interaction. Moreover, some results suggest that TAP can be more effective than traditional methods but more research is needed (Nelson et al. 2003; Powers and Emmelkamp 2008). Only with systematic studies of the design parameters of the technologies can potential advantages of TAP be identified.

Objectives

The aim of this article is to raise awareness of the importance of the human–technology interaction in TAP and to foster collaborations between psychotherapists and HF/E professionals so that innovative design principles can be developed. Toward these aims, this article examines the implications of findings in HF/E for the use of technologies in psychotherapy. Only technologies used to aid therapists deliver therapy are considered, rather than technologies used to deliver therapy with minimal or no guidance from a therapist (Titov 2011), or technologies used to help clients adhere to therapy (Clough and Casey 2011b).

Although the role of the client-therapist relationship, the therapeutic alliance, may vary with the type of treatment (Bee et al. 2010), the alliance is considered essential for treatment effectiveness (Arnd-Caddigan 2012; Bee et al. 2008; Simpson 2009). Even when therapy is not face-to-face and therapist contact is minimal, a strong alliance can be developed (Anderson et al. 2012). Thus, it is important to consider how technologies can affect the alliance. Components of alliance include agreement and collaboration on goals and tasks, as well as the bond and trust between the client and the therapist (Arnd-Caddigan 2012). In addition, treatment effectiveness depends on the rapport that is developed through communications between the client and therapist. Hence, it is reasonable to expect that adverse effects of technology on communication may affect rapport and consequently the effectiveness of the treatment (Manning et al. 2000). In short, it is essential to examine the potential effects of technologies on communication, trust, collaboration, and interpersonal interactions. Investigations of such factors can be found in the HF/E literature and although they were not conducted in the context of psychotherapy, results have potentially important implications for TAP.

Method

Literature searches were conducted in three steps using the electronic search engines PsycInfo, Academic Search Complete, and Psychology and Behavioral Sciences Edition. First, the literature was searched to identify

technologies that have been used in psychotherapy. Search combinations included the terms psychotherapy, therapy, mental health, technology, on-line, Internet, and telemedicine. This resulted in an extremely large number of articles including many that were superfluous to the aims of the search. Subsequent searches were limited to the technologies of videoconferencing, virtual reality, and e-therapy (e-mail, chat, mobile phones). Second, the literature was searched to determine how these technologies were used in psychotherapy and to ascertain the effectiveness of therapy mediated by such technologies. These searches were limited to English, peer-reviewed journal articles classified as a literature review, systematic review or meta-analysis. Search terms included psychotherapy paired with virtual reality, videoconferencing, text-based communication, instant-messaging, text-messaging, online, phone, and Internet. Review articles were examined manually to identify randomized-control studies that indicated how the technologies were used in therapy, and their effectiveness compared with traditional methods. Finally, the literature was searched to identify how the field of HF/E has been or could be applied to the use of technologies in psychotherapy. Search combinations included the terms human factors, psychotherapy, virtual reality, text-messaging, text-based communication, and videoconferencing. Review articles and empirical articles that had potential implications for TAP, particularly for the relationship between the therapist and client, were identified.

Videoconferencing

During videoconferencing, the client and the psychotherapist are not in the same location but they can both see and hear each other through video images; applications include Skype and FaceTime. A primary benefit of videoconferencing is to increase treatment access, for example, to people in rural areas and prisons, to people who are disabled or economically disadvantaged, and to people who have anxiety disorders which result in avoidance of travel or large groups of people (Backhaus et al. 2012; Simpson 2009).

The Use of Videoconferencing in Treatment

Videoconferencing has been used in a variety of clinical settings including the treatment of trauma, mood, anxiety, and eating disorders, and can result in therapeutic alliance and clinical outcomes comparable to face-to-face therapy (Backhaus et al. 2012). For example, in a randomized control study (Nelson et al. 2003), the effectiveness of cognitive-behavioral therapy to treat childhood depression was measured when the treatment was administered with videoconferencing or face-to-face (control). Twenty-eight children aged 8–14 years who were diagnosed with childhood depression completed 6–8 weeks of treatment (with parent). Scores on the Children's Depression Inventory, and the Schedule for Affective Disorders and Schizophrenia for School Age Children-Present Episode (mood section) were measured before and after the intervention. Both groups exhibited a decrease in depressive symptoms after treatment. The videoconferencing group showed a greater decrease compared with the face-to-face group.

Findings from HF/E Relevant to the Use of Videoconferencing in Treatment

Findings in HF/E are relevant to the use of videoconferencing in treatment. These include effects of videoconferencing on psychological distance, communication, trust and collaboration, and individual differences.

Psychological Distance and Communication

There are important differences between videoconferencing and face-to-face communications that have implications for interpersonal interactions and thus for the client-therapist relationship. For example, in videoconferencing, the communicating parties are not only physically separated compared to a face-to-face situation, but the communication is perceived as having a greater psychological distance (Suwita et al. 1997). Specifically, videoconferencing is perceived as more reserved and less open than face-to-face conversation. Similarly, the image of the person as measured on the viewer's eye often is smaller than the image that would occur in a face-to-face interaction. This results in the speaker being perceived as being too far away and in greater difficulties recognizing nonverbal signals.

Moreover, the video image typically shows only a partial view—head and torso—of the person who is communicating. This prevents a view of some nonverbal signals, such as gestures, which are important for communication (Fussell and Benimoff 1995). Gestures result in better comprehension and speech production than when gestures are not used (Driskell and Radtke 2003). In addition, the visibility of gestures allows speakers to see mimicry of nonverbal behaviors that may result in greater liking (Chartrand and Bargh 1999). Importantly, mutual liking may contribute to alliance (Arnd-Caddigan 2012).

Finally, videoconferencing does not result in proper eye contact (Suwita et al. 1997), which is important because it may reflect intimacy and the desire to initiate social interaction (Argyle 1972), and it may affect the flow of communication (Suwita et al. 1997) and the quality of the interaction (Tam et al. 2007). Moreover, the aversion of gaze may reduce perceived credibility (Hemsley and Doob

1978). The American Telemedicine Association recommended that gaze angle be minimized during videoconferencing (Yellowlees et al. 2010).

Collaboration and Trust

Videoconferencing can affect collaboration and trust which are important for the therapeutic alliance. In one study (Bradner and Mark 2002), performance on collaboration and cooperation tasks was measured when the tasks were performed via videoconferencing and instant messaging (results did not differ between these conditions). Participants performed these tasks under two conditions of apparent distance. The participants were led to believe that they were working with someone in a distant city or in the same city. In fact, they were working with a confederate in a nearby room. When apparent distance was far, participants were more likely to give deceptive answers, were less convinced by their partner, and initially cooperated less with their partner. They also initially trusted their partner less. It is not solely physical distance but rather the perception of distance that affects interpersonal interactions.

Another study suggested that the development of trust in a group context was facilitated when a face-to-face meeting occurred before communicating with an electronic mailing list (Rocco 1998). Similarly, in the context of a mock job interview, the participant in the role of employer gave the participant in the role of job applicant higher ratings of friendliness, honesty, and job suitability when the two parties had a pre-interviewing meeting that was face-to-face compared with video (Derrer et al. 2006). The implication is that an initial face-to-face meeting may have the same facilitating effect when using videoconferencing in psychotherapy.

Individual Differences

When using videoconferencing for treatment, it is important to consider the demographics of the client and how they communicate. In a human factors analysis of communication, Rice and Stohl (2006) noted that communication style, use of nonverbal cues, and eye contact can vary with gender, race, age, nationality and ethnicity. For example, messages on websites oriented to women contained more personal experiences, emotional interactions, and less authoritative language whereas those oriented to men had less personal interaction and were more authoritative and private. The authors noted further that some cultures rely more on context, such as nonverbal cues and indirect messages compared with other cultures which rely more on words (Nisbett 2003; Tang et al. 2006).

In summary, the design and implementation of videoconferencing technologies can affect communication, collaboration, and trust and thus potentially the therapeutic alliance and treatment outcomes. Potentially relevant factors include the visibility of gestures, image size of the therapist and client, the apparent distance of the therapist, eye contact, client demographics, and initial face-to-face interaction prior to videoconferencing. It is important for future research to determine whether and how these and other factors affect the client's treatment experience and outcomes, and whether such effects vary with the diagnosis and treatment approach. Finally, it should be noted that therapies delivered without face-to-face interaction allow some clients to disclose sensitive information (e.g., suicidal thoughts), which can be an advantage of text-based communication over videoconferencing (Emmelkamp 2005).

Text-Based Communications

This section focuses on text-based communications. In this case, people are not in the same location and cannot see each other. Rather, they communicate through text. Examples include instant messaging, e-mail, chat rooms, and text-messaging to mobile phones.

The Use of Text-Based Communication in Treatment

Text-based communications have been used to deliver treatment through electronic mail, chat rooms, and websites, to treat concerns such as depression, anxiety, and eating disorders, and the use of such communications can result in effectiveness comparable to traditional face-to-face therapy for a variety of concerns (Barak et al. 2008). For example, in a randomized control study (Paxton et al. 2007), the effectiveness of manualized cognitive-behavioral therapy for body dissatisfaction and disordered eating was measured when treatment was delivered face-to-face, via the Internet, or in a delayed treatment control group. One-hundred-sixteen women, who met inclusion criteria using scores on the Body Shape Questionnaire and Bulimia Test-Revised, completed 8 (minimum of 4) weeks of therapist-led group sessions. In the Internet group, the therapist and group participants engaged in synchronous text-based communications in a chat room with the availability of a discussion board to allow asynchronous communication between sessions. Various instruments were administered before and after treatment (e.g., Body Image Avoidance Questionnaire, Dutch Eating Behavior Questionnaire-Restraint Subscale). Both treatment groups showed improvements in body dissatisfaction and in eating attitudes and behaviors, compared with the control group, after treatment and 6 months following treatment. Improvements were greater in the face-to-face than the Internet group.

Findings from HF/E Relevant to the Use of Text-Based Communication in Treatment

Findings in HF/E are relevant to the use of text-based communication in treatment. These include effects of text-based communication on persuasion, credibility, self-disclosure, and communication.

Persuasion and Credibility

Communicating with text can affect persuasion and credibility and thus potentially the client-therapist relationship. For example, Moon (1999) asked participants to perform a task that included typed communications with another person. Unbeknownst to the participant, the other person was actually a computer. Apparent distance and response delays were manipulated. Distance was near, defined as several miles away, or far, defined as several thousand miles away. Response delay, the time it took for the computer to start typing its response, was short (0–1 s), medium (5–10 s) or long (13–18 s). Results indicated that persuasion was greater in the near condition than in the far condition. Medium delays led to more persuasion than short and long delays. Furthermore, the perceived credibility of the communicating partner was higher in near than far conditions and was higher in the medium-delay than in the long-delay conditions.

Self-Disclosure and Communication

Communicating with text may affect a client's self-disclosure. In a comparison of communications with a chat program and face-to-face communication, two people were asked to work together on a dilemma and come to a joint decision (Joinson 2001). People revealed more personal information when using the chat program than when communication was face-to-face. However, self-disclosure was lower when the two parties saw their partner on the video screen in real time which eliminated visual anonymity. These results are consistent with evidence that some clients disclose more in computer interactions than in face-to-face interactions (Emmelkamp 2005).

Similarly, a higher proportion of questions was asked and a higher proportion of self-disclosures occurred during collaboration on a decision-making problem when participants used text-messaging (instant-messaging) compared with face-to-face communications (Tidwell and Walther 2002). The communications also differed. Text-messaging resulted in a higher proportion of questions characterized as more intimate whereas face-to-face communications consisted of a higher proportion of nonpersonal statements such as back-channels and fillers. The authors suggested that people using text-messaging tried to compensate for the limitations of the technology by making their conversation more personal, that is, by asking more intimate questions and disclosing more personal information.

In summary, the design and implementation of text-based communication technologies can affect persuasion, credibility, self-disclosure, and communication, and thus potentially the therapeutic alliance and treatment outcomes. Relevant factors include the therapist's apparent distance, response delays, and visual anonymity. It is important for future research to determine whether and how these and other factors affect the client's treatment experience and outcomes, and whether such effects vary with the diagnosis and treatment approach.

Virtual Environments

Virtual environments are computer-generated or otherwise synthetic worlds in which people interact, and serve as surrogates of the real world. Virtual environments can be viewed with a desktop computer or with more immersive displays such as helmet-mounted displays (HMD) and cave automatic virtual environments (CAVEs; Krijn et al. 2004).

The Use of Virtual Environments in Treatment

Virtual environments have been used in a variety of clinical settings including the treatment of posttraumatic stress disorder and various specific phobias, and can result in reduction of symptoms (Parsons and Rizzo 2008). For example, in a randomized control study (Rothbaum et al. 2006), the effectiveness of virtual reality exposure therapy (VRET) for fear of flying was compared with standard (in vivo) exposure therapy and a wait list control. Seventy-five adults who met relevant DSM-IV criteria completed 8 treatment sessions across 6 weeks, beginning with 4 sessions of anxiety management training. Participants in the VRET condition wore an immersive head-mounted display that simulated a window-seat view inside an airplane which progressed through different stages of flight (e.g., engines start, taxi to runway, take-off, flight, landing). Standard exposure therapy was conducted at an airport and included imaginal exposure inside a plane. Scores on the Fear of Flying Inventory, and the Questionnaire on Attitudes Toward Flying were measured before and after treatment, and at 6- and 12-month follow-ups. Virtual and standard exposure groups exhibited post-treatment improvements compared with the control group and did not differ from each other. Improvements were maintained after 6 and 12 months.

Findings from HF/E Relevant to the Use of Virtual Environments in Treatment

Findings in HF/E are relevant to the use of virtual environments in treatment. Studies have identified important

differences between virtual environments and real environments that have implications for the effectiveness of virtual environments for treatment. Two critical aspects of virtual environments are presence and adverse side effects.

Presence

Presence is when the user experiences being in a place other than where he or she is physically located and can be measured with a presence questionnaire (Witmer and Singer 1998). Presence is important because more presence leads to more enjoyment, more effectiveness, and greater acceptance by users (Stanney and Cohn 2006). Although it has been assumed that presence is needed for treatment effectiveness, results of an acrophobia study indicated that VRET can be equally effective with low (HMD) and high (CAVE) presence (Krijn et al. 2004). However, not everyone can achieve presence, and a minimal degree of presence may be needed to induce anxiety during VRET (Krijn et al. 2004; Rothbaum et al. 2006). It is important to understand the factors that contribute to presence, but most studies of VRET do not examine presence (Powers and Emmelkamp 2008).

Studies in the HF/E literature have identified numerous factors that affect presence (Sadowski and Stanney 2002; Witmer and Singer 1998; Youngblut 2006). One example is the ease of interaction between the user and the system. Difficulties in navigation and interaction decrease presence. A related factor is user-initiated control. More user control over the virtual environment leads to more presence. Another factor is immersion, which is greater when a user interacts with the virtual environment while wearing an HMD rather than viewing a desktop monitor. More immersion results in more presence. Preliminary evidence suggest that individual differences also influence presence. For example, people who are 35–45 years of age may experience less presence than people 10–20 years of age, and people who prefer to rely on the visual modality (e.g., images) may experience a greater sense of presence than those reliant on the auditory modality (e.g., internal dialogue) (Alsina-Jurnet and Gutiérrez-Maldonado 2010).

Adverse Side Effects

Adverse side effects due to exposure to virtual environments are common and can limit the use of this technology (Stanney et al. 2006; Stanney and Cohn, 2006). Effects include nausea, vomiting, dizziness, loss of balance, disorientation, fatigue, drowsiness, headache, and eyestrain. More than 80 % of individuals exposed to virtual reality may experience adverse side effects to some degree. About 25 % will drop out within the first 20 min of exposure, and about 1.5 % will vomit. Adverse side effects detract from the effectiveness of the virtual environment, can influence how many people use the technology and consequently reap the benefits of the treatment, and can result in postural instability and potentially falls, which can create liabilities for the therapist. Simulator sickness can be measured with the Simulator Sickness Questionnaire (Kennedy et al. 1993).

Studies in the HF/E literature have identified factors that contribute to adverse side effects (Stanney et al. 2006; Stanney and Cohn 2006). These include large fields of view (as occur in more immersive virtual systems), system lags, sensory conflicts, high rates of optic flow, and relatively more degrees of movement control. As with presence, there are individual differences in the way that people experience the side effects of virtual environments. For example, people who may be especially affected by virtual environments include individuals prone to motion sickness, females, and those older than 40 years. Results suggests that adverse side effects can be minimized by limiting the duration of exposure to the virtual environment, minimizing characteristics of the virtual environment system that contribute to adverse side effects (e.g., system lags, sensory conflicts), having users be well rested, and having clients remain at the site until symptoms dissipate.

In summary, the design and implementation of virtual environments contribute to the effectiveness of the virtual environment and its acceptability to the user, the health and safety of the user, and thus potentially treatment outcomes. Relevant factors include presence, adverse side effects, and individual differences. It is important for future research to determine whether and how these and other factors affect the client's treatment experience and outcomes, and whether such effects vary with the diagnosis and treatment approach.

Conclusions

Technologies are being used increasingly to aid psychotherapy and are becoming an integral part of mental health treatment (Bray 2010). Although prior studies compared results of TAP to traditional treatments, there are insufficient studies of the impact that specific design parameters and use of the technologies potentially have on the client and therapist, and treatment outcomes. Moreover, although HF/E focuses on the study of human–technology system, there has been little attention to the design of technologies used in mental health care (DeLucia and Harold, 2011) even though it is well known that technologies affect various aspects of human behavior (Hancock et al. 2005; Wickens et al. 1998).

This article presented examples of how the design and use of technologies may have potentially important effects on the therapeutic alliance and treatment outcomes, and on the willingness of clients to use a technology. Future studies are needed to determine the effects of specific design factors on treatment. At the least, studies that compare TAP to traditional methods should report as much detail as possible about the human–technology interaction including design variables and client responses. In videoconferencing, relevant factors include gaze angle, image size, and visibility of gestures. In text-based communication relevant factors include response delays and visual anonymity. In virtual environments, relevant factors include immersion, user interactivity, and duration of exposure to the virtual environment. Relevant client responses include psychological distance, trust, self-disclosure, presence, and adverse effects. In addition, it is important to determine whether effects of such factors depend on the type of treatment, the nature and severity of disorder, and the demographics of the client.

More generally, it is important to develop design principles for TAP. An example of a design principle in HF/E is "know thy user" or "honor thy user" (Kantowitz et al. 2009). This means that the design of a human–technology system should consider the users of the system (and their capabilities, limitations, preferences, prior experiences, expectations, etc.) and the tasks they will perform. This principle applies to TAP, and should incorporate knowledge of the client's disorder. For example, learning is degraded under conditions of relatively high cognitive demands (Wickens et al. 1998). Consequently, if therapeutic treatment requires the client to learn a technique or method from a provider during TAP, it is important that the design of the technology minimizes cognitive demands on the client (e.g., divided attention, memory load). Moreover, memory, attention and other cognitive abilities may depend on the nature and severity of a client's disorder, as well as the age and physical health of a client. In short, it is important to "know thy client" when designing and implementing technology for TAP. It is hoped that this paper will foster discussions and collaborations between psychotherapists and HF/E professionals so that effective and innovative technologies and, ultimately, design principles for TAP can be developed.

Acknowledgments Patricia R. DeLucia, Stephanie A. Harold, Yi-Yuan Tang, Department of Psychology, Texas Tech University. Patricia R. DeLucia served as president of Division 21 of the American Psychological Association in 2010–2011. This article is based on her presidential address for Division 21, presented at APA's 119th Annual Convention on August 4, 2011, in Washington, D.C. We are grateful to Patrick Crittendon for help with the literature review and to the students and faculty in the Texas Tech University Human Factors Chat for feedback on the presentation.

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