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Future Directions in the Design, Development, and Investigation of Technology as a Service Delivery Vehicle

Deborah J. Jones, Ph.D.
University of North Carolina at Chapel Hill

Deborah J. Jones: djjones@email.unc.edu

Abstract

Treatment outcome research with children and adolescents has progressed to such an extent that numerous handbooks have been devoted to reviewing and summarizing the evidence base. Ensuring that consumers of these advancements in state-of-the-field interventions have the opportunity to access, engage in, and benefit from this evidence-base, however, has been wrought with challenge. As such, much discussion exists about innovative strategies for overcoming the gap between research and practice; yet, no other potential solution that has received more attention in both the popular and academic press than technology. The promise of technology is not surprising given the fast-paced evolution in development and, in turn, a seemingly endless range of possibilities for novel service delivery platforms. Yet, this is precisely the most formidable challenge threatening to upset the very promise of this potential solution: The rate of emerging technologies is far outpacing the field's capacity to demonstrate the conceptual or empirical benefits of such an approach. Accordingly, this paper aims to provide a series of recommendations that better situate empirical enquiry at the core of a collaborative development, testing, and deployment process that must define this line of work if the promise of mental health technologies is going to be a reality for front-line clinicians and the clients they serve.

Child and adolescent mental health as a subfield or specialty area in psychology has evolved in a relatively dramatic way from its infancy. As reviewed by others in rich detail, it was not until the early 1960s that "Child Clinical Psychology" became Section 1 of Division 12 ("Clinical Psychology") of the American Psychological Association (APA) (see Erikson, 2013; Routh, 1991; Routh, Patton, & Sanfilippo, 1991, for reviews). In turn, interest evolved for specialty training in child and adolescent service delivery (see Perry, 1978; Routh, 1985a; 1985b, for reviews); however, the "Specialty in Child Clinical Psychology" was not officially recognized by APA until 1988 and Division status, "Division of Child Clinical Psychology" (Division 54; established in 2000), achieved another decade later (with the name change to "Society for Child and Adolescent Psychology" in 2001) (see Erikson, 2013; Routh, 1991; Routh, Patton, & Sanfilippo, 1991, for reviews).

As the field of child and adolescent clinical psychology has continued to evolve, so too has the clinical complexity, scientific rigor, and professional demands of our evidence-based practice approach to assessment and treatment (see APA, 2006; APA, 2008; Benjamin et al., 2011; Youngstrom, 2012, for reviews). As reflected in the growing library of volumes and updates dedicated to organizing, presenting, and summarizing updates in the state of the evidence-base, the field has progressed far beyond the initial reliance on the downward extension of primarily cognitive and behavioral techniques established with and for adults to

Correspondence regarding this article should be directed to Deborah J. Jones, Department of Psychology, CB # 3270, University of North Carolina at Chapel Hill, Chapel Hill, NC 27599-3270.

the availability of well established treatments developed for and tested with children and adolescents (see Bearman & Weisz, 2012; Benjamin et al., 2011; Chorpita et al., 2011; Silverman & Hinshaw, 2008; Stallard, 2002; Weisz, Hawley, & Doss, 2004; Weisz & Kazdin, 2010, for reviews). This established foundation of treatment outcome research now affords a rich range of prevention and intervention options for children, adolescents, and their families, including programs that aim to prevent negative behavioral outcomes in vulnerable groups, as well as a host of others that aim to ameliorate symptoms and improve the quality of life of youth with disorders on the developmental, as well as internalizing and externalizing, spectrums.

As work to achieve the goal of integrating state-of-the-field assessment and treatment tools with clinical judgment and expertise has evolved (see APA, 2005; APA, 2006; APA, 2008; Beidas & Kendall, 2010; Kazak et al., 2010; Kratochwill & Hoagwood, 2006; Youngstrom, 2012, for reviews), so too have challenges emerged. Significant, if not primary, among these is this: Ensuring that the would be consumers of these advancements have the opportunity to access, engage in, and benefit from this evidence-base (see APA, 2008; Comer, Elkins, Chan, & Jones, in press; New Freedom Commission on Mental Health, 2003; Kataoka, Zhang, Wells, 2002; Kazak et al., 2010; Schoenwald et al., 2008; Weisz, Donenberg, Han, & Weiss, 1995, for reviews). First, it remains unknown the extent to which front-line mental health agencies and their providers are adequately prepared for the delivery of an evidence-based practice approach (see Beidas & Kendall, 2010; Sanders & Turner, 2005; Schoenwald et al., 2008, for reviews). At the root of this challenge, as reviewed elsewhere, is the pronounced shortage of front-line providers, particularly in underserved areas, let alone those with specialty training in child and adolescent clinical psychology (see APA, 2008; New Freedom Commission on Mental Health, 2003; U.S. DHHS, 2008, for discussions). As such, many on-the-ground mental health service providers serving children, adolescents, and their families may not have had the opportunity for formal training or expertise in an evidence-based practice approach.

When such providers and services are supported in the community and available to families, those who may benefit the most tend to be the least likely to seek and engage in evidence-based interventions (see APA, 2008; Comer, Elkins, Chan, & Jones, in press; Interian, Lewis-Fernández, & Dixon, 2013; Jones et al., 2013; Kataoka, Zhang, & Wells, 2002; Kazak et al., 2010; New Freedom Commission on Mental Health, 2003; U.S. DHHS, for reviews). Our treatments work, but such efficacy also typically comes with a fairly demanding catalog of cognitive and behavioral skills and both in- and out-of-session practice that requires substantial investment of family time. Such demands typically include transportation to and from clinic-based services, at least weekly clinic appointments lasting an hour (sometimes more) of the family's time, and a substantial level of home-based practice of skills that is a hallmark of success in evidence-based treatment approaches. These demands, in turn, may be difficult for even advantaged families given the modern demands of two-earner households and the competing challenges of navigating the work-family balance, let alone underserved families for whom such commitments of time, travel, and financial resources may be even more challenging, if not impossible (see APA, 2008; Jones et al., 2013; Kataoka, Zhang, & Wells, 2002, for reviews).

Finally, when children, adolescents, and families have access to and engage in treatment, core elements of evidence-based treatment manuals may be difficult to implement in a standardized way in front-line practice settings (see APA, 2008; Beidas & Kendall, 2010; Kazak et al., 2010; Kratchowill & Hoagwood, 2006, for reviews). In contrast to university-based training clinics, the rigid control characteristic of treatment outcome research is much more difficult, again some may say impossible, in mental health service settings operating within the confines of demanding caseloads, little or lack of therapist supervision, and the

mandates of insurance or social service coverage and reimbursement. For example, presuming agency administration and providers support an evidence-based practice approach in theory, they simply may not have the time or resources to implement the core elements of the manual that are deemed critical for treatment efficacy. As highlighted by representative reviews of state-of-the-field treatments (see Bearman & Weisz, 2012; Benjamin et al., 2011; Chorpita et al., 2011; Silverman & Hinshaw, 2008; Stallard, 2002; Weisz, Hawley, & Doss, 2004; Weisz & Kazdin, 2010, for reviews), one such element common to most, if not all, evidence-based treatment programs is rehearsal or skill practice both within the treatment setting, but equally, if not more, importantly, within the context of the daily experiences of the child or adolescent and family. Such an approach requires extensive time and commitment on the part of the family, but the therapist as well whose sessions will likely last longer than the proscribed 50-minute treatment hour and whose commitment typically must extend to some level of monitoring and coaching of practice that occurs beyond the treatment setting. As such, practicality may by necessity move far beyond "adherence and flexibility: they can and do exist" to a watered down treatment regimen that looks very little like the empirical foundation upon which it evolved (see Forehand, Dorsey, Jones, Long, & McMahon, 2010, p. 258; Kendall, Chu, Gifford, Hayes, & Nauta, 1998; Mazzuchelli & Sanders, 2010, for reviews).

With the aim of addressing the aforementioned challenges, calls have sounded for innovative strategies to better ensure that mental health consumers have the opportunity to access, engage in, and benefit from the established evidence-base (see Bennett-Levy et al., 2010; Kazak et al., 2010; Kazdin & Blasé, 2011; Weisz, Donenberg, Han, & Weiss, 1995).). The range of proposed solutions vary; yet, there may be no other strategy for increasing the reach and impact of evidence-based treatment in clinical psychology that has received more attention in both the popular and academic press than technology (see Aguilera & Muenich, 2012; Boshen & Casey, 2008; Clough & Casey, 2011; Comer et al., in press; Enock & McNally, 2012; Jones et al., 2013; Kazdin & Blasé, 2011, for reviews). Although the notion of using technology to enhance mental health care is not new (New Freedom Commission on Mental Health, 2003), the rapid proliferation of platforms more widely available to consumers than ever before has perhaps renewed interest in and the promise of the potential progress achievable by such an approach.

In child and adolescent clinical psychology in particular, progress has indeed occurred in models that range from remote technologies for supervision and treatment (e.g., videoconferencing; see Comer et al., in press; Funderburk, Ware, Altshuler, Chaffin, 2008; Nelson & Bui, 2010, for reviews) to computerized treatment delivery formats, particularly for disorders on the internalizing spectrum (e.g., CD-ROM, web-based interventions; Kendall, Khanna, Edson, Cummings, & Harris, 2011; Khanna & Kendall, 2010; also see Calear, Christensen, & Griffiths, 2010; Comer et al., in press; Gass, 2013; Richardson, Stallard, & Velleman, 2010, for reviews), to technology-enhanced assessment and treatment models (e.g., mobile and smartphone-enhanced; e.g., Jabaley, Lutzker, Whitaker, & Self-Brown, 2011; Mintz, Branch, March, & Lerman, 2012; Silk et al., 2011; also see Jones et al., 2010; Jones et al., 2013, for reviews). Despite progress on this pioneering front, the rate of emerging technologies is far outpacing the field's capacity to demonstrate the empirical benefits with regard to outcome or the processes or mechanisms by which such improved outcomes are expected to occur (see Clough & Casey, 2011; Enock & McNally, 2013; Jones et al., 2013; Novotney, 2011; Riley et al., 2009; Ritterband et al., 2011, for reviews). Although this lag in the literature is characteristic of services research more broadly as well, it is perhaps especially noteworthy in child and adolescent clinical psychology in particular given the foundation in theory and research that has guided the evolution of the field from its early inception.

TECHNOLOGY AS A DELIVERY VEHICLE

Importantly, the aim of this paper is not to elucidate specific conceptual models, research questions, or hypotheses, as such initiatives have already been laid out very carefully elsewhere, including by academics, advocates for mental health reform, and funders interested in the progress of research in this area (see Chambers, 2011; New Freedom Commission on Mental Health, 2003; Enock & McNally, 2013; Kumar et al., 2013a; Nilsen, Riley, & Heetderks, 2013; Riley et al., 2009; Riley, 2012; Ritterband et al., 2011, for examples). Rather, this paper aims to provide a series of recommendations for situating research investigators and empirical enquiry at the nucleus of a collaborative development, testing, and deployment process that must define this line of work if the promise of mental health technologies is going to be a reality for front-line clinicians and the clients that they serve (see Chambers, 2011; Kumar, Nilsen, Pavel, & Srivastava, 2013b; Nilsen, Riley, & Heetberks, 2013, for reviews). Specifically, this article highlights what may be considered "the basics" of such a collaborative investigative process, including the critical value of a conceptual framework and research design, but also more practical aspects of this work, such as considerations when selecting the technology platform for a particular intervention and specifications for the functionality of that platform. Attention to the conceptual, scientific, and practical aspects of this work is critical if the promise of technology as a viable, sustainable, and cost-effective delivery vehicle in child and adolescent mental health is to become a reality, particularly one that will help us to overcome, rather than exacerbate, the challenges in evidence-based service delivery. Accordingly, representative reviews and empirical articles from distinct, but increasingly interrelated fields, including psychology, public health, computer science, and engineering, as well as industry data, are cited in service of the recommendations that are provided. It is the goal of this paper, in turn, to foster further discussion, but most importantly to fuel investigations that put a premium on efficacious, as well as feasible and sustainable, mental health technologies to better meet the mental health and treatment needs of children, adolescents, and their families.

1. Establish a Conceptual Framework that Considers both Structure and Function

The complementary aspects of the structure and function of technology have long been a topic of discussion among academics and industry leaders interested in both design and development (see Houkes, Kroes, Meijers, & Vermaas, 2011; Kroes, 1998; van de Poel & Goldberg, 2010; Vermaas, 2010, for reviews). In child and adolescent clinical services work for example, structure can at the most basic level be defined as the platform or device that will ultimately serve as the delivery vehicle for the intervention or components of the intervention to mental health consumers, in this case children, adolescents, and their families. Considering structure at this broadest level, a host of potential delivery vehicles are available to investigators working in child and adolescent services research (e.g., smartphones, notebooks), with new possibilities always on the horizon as well (e.g., wearable technology) (see Brauer & Barth, 2013; Curtis, 2013; Farber, 2013; Kumar, 2013a; Kumar, Nilsen, Pavel, & Srivastava, 2013b; Nilsen, Riley, & Heetberks, 2013, for reviews). It is precisely as the range of available and emerging possibilities proliferates that the selection of the delivery vehicle becomes increasingly important, including in very practical ways such as accessibility among the target consumers, including child and adolescent clients and their families, as well as the front-line providers who serve them.

If an investigative team is interested primarily in bridging the research to practice gap with underserved (e.g., ethnic minority, low income) children, adolescents, and families for example, turning to technology in particular as a potential solution may seem counterintuitive due to challenges inherent in the "digital divide" that traditionally limits access to and use of technology among the very populations the field of child and adolescent clinical psychology aims to better serve. Yet, consideration of available platforms suggests

that there is more rapid uptake of some technologies more than others, including among the underserved. As highlighted by industry data reported by the Pew Research Center, the vast majority (91%) of Americans own a mobile phone (see Duggan & Smith, 2013; Smith, 2013, for reviews). As with other technologies, it remains the case that more affluent and higher educated consumers are in fact more likely to own mobile phones (see Duggan & Smith, 2013; Smith, 2013; Zikuhr, 2013; Zikuhr & Smith, 2012, for reviews). Rates of ownership are rising in all socio-demographic groups, however, including ethnic and racial minorities, as well as the low income and less educated, who traditionally have less access to technology at home, work, or school (Smith, 2013). Fueling the rise in mobile phone ownership generally is the increased uptake of smartphones in particular (56% of Americans report smartphone ownership; see Duggan & Smith, 2013; Smith, 2013, for reviews), likely due in large part to the rapid decline in the price of available platforms coupled with a rise in options for low-cost and subsidized service plans (e.g., Walmart lists 40 mobile phones, including smartphones, on its website retailing for prices ranging from $.01 to $49.99 with contracts starting at $39.88/month for unlimited talk, text, and web). As such, the increase in affordability, uptake, and use across demographics suggests smartphones may be an ideal platform (i.e., delivery vehicle) to increase the reach and impact of health care services, including to traditionally underserved groups.

Selection of the delivery vehicle, however, has more than practical implications as well, which leads to the consideration of the second critical aspect of technology or the function (see Houkes, Kroes, Meijers, & Vermaas, 2011; Kroes, 1998; van de Poel & Goldberg, 2010; Vermaas, 2010, for reviews). In fact, some have highlighted that functionality and the conceptual framework guiding functionality are ultimately the fundamental qualities of the technology, without which the delivery vehicle would simply be considered a “black box” (Ritterband et al., 2011, p. 21; also see Kroes, 1998; Riley et al., 2009). Importantly, conceptual framework in this paper is being used at the broadest level to refer to “the ways ideas are organized to achieve a research project’s purpose” (Shields & Rangarian, 2013, p. 24). Within this rubric, the importance of functionality may at first seem obvious or overly simplistic; yet, there is general consensus in services research more broadly that technology is being used with relatively little consideration for what advances are expected to occur by leveraging technology (e.g., increasing engagement in treatment), through what mechanisms or processes are such advances expected to occur (e.g., increasing connection with treatment program and support from provider), and, in turn, what functionality is necessary to achieve these mechanisms and processes (i.e., a conceptual framework; Williams, Lynch, & Glasgow, 2007; also see Jones et al., 2013; Kumar et al., 2013a; Riley et al., 2009; Ritterband 2011, for reviews).

In clinical services work in particular, perhaps what may be considered most central to the conceptual framework and, in turn, desired functionality of the technology is the extent to which therapist involvement is hypothesized to impact child and adolescent outcomes. Others have reviewed the options for therapist involvement in technology-delivered or enhanced interventions, ranging from minimal or no substantive therapist involvement (e.g., CD-ROM or web-delivered application) to technology conceived of and utilized as an enhancement to, rather than replacement of, clinic-based services (see Barak et al., 2009; Clough & Casey, 2011; Mohr, Cujpers, & Lehman, 2011; Tate & Zabinski, 2004, for reviews). For example, research on these options suggests that some level of therapist involvement may be optimal, if not necessary, for the most distressed and disadvantaged clients (see Jones et al., 2013; Mohr, Cujpers, & Lehman, 2011; Tate & Zabinski, 2004, for reviews). In turn, if therapist involvement is deemed to be critical to treatment success and technology is conceived of as an enhancement or “adjunct” (Clough & Casey, 2011) to traditional therapist-delivered treatment approaches, then the conceptual and empirical question becomes the extent to which the communication between the client (or the client’s

family) must occur in real-time (e.g., videoconferencing), can be asynchronous (e.g., email, web chats), or whether some combination of the two is optimal (Tate & Zabinski, 2004, for a review).

For example, some interventions rely on text messages (see Aguilera & Muenich, 2012; Boshen & Casey, 2008; Jones et al., 2013; Militello, Kelly, & Melnyk, 2012; Wei, Hollin, & Kachnowski, 2011, for reviews). The conceptual framework behind such functionality may be to create a mechanism for increased communication between the therapist and client and, in turn, connection to the treatment program and support for engagement in treatment (e.g., reminders regarding appointments, reinforcement for session attendance, questions regarding home work). If such efficient messaging is the primary function that the investigators want the technology to serve and text messages provide a feasible way to convey these messages (e.g., non-sensitive information, information can be conveyed in short messages etc.), then traditional cellular/mobile phones may be sufficient platforms for such a technology-enhanced approach. That is, traditional cell phones afford the option for text messages, may be in the hands of more consumers at this point in time, and are certainly less expensive devices to provide to families who may not own a mobile phone at all. If the conceptual framework behind enhancing the intervention with technology is more far-reaching, however, and the desired functionality to achieve these goals is more diverse, such as needing to increase the opportunities for out-of-session skill modeling opportunities (e.g., skills video series) or remote, face-to-face coaching sessions (i.e., videoconference), then another device, such as a smartphone or a tablet, may make more conceptual and practical sense, given the range of applications that it affords to the therapist and the client (see Jones et al., 2013, for a review).

Of course, there is a significant caveat to consider in decision-making regarding both structure and function of the technology in the context of treatment outcome research. That is, decisions regarding structure and function must be made with the full recognition that the particular technology that is the focus of a line of research may be virtually obsolete in the time it takes to move from the research question to study design and implementation to publication of findings, not to mention deployment from research to practice. Accordingly, this paper next considers optimal strategies for conducting research with available platforms, but a process for doing so that affords greater opportunity to leverage the functionality of emerging platforms as they continue to evolve as well.

2. Develop and Test Desired Functionalities via an Initial Proof-of-Concept Approach

The working model in treatment outcome research has generally been to develop a specific treatment manual for a specific disorder or constellation of symptoms or risk factors, then to determine the efficacy of that manual via the gold standard randomized control trial. This model, which typically includes fully fleshing out the entire contents of the treatment manual prior to testing, may continue to work well for interventions that rely on functionalities that are a feature of available platforms. For example, interventions that rely on text-messaging entirely, particularly models in which therapists and clients are generating the texts (rather than pre-programmed, auto-generated texts), should conceivably add little or no cost to the standard evidence-based treatment model (see Aguilera & Muenich, 2012; Boshen & Casey, 2008; Jones et al., 2013; Militello, Kelly, & Melnyk, 2012; Wei, Hollin, & Kachnowski, 2011, for reviews).

Where the more traditional approach to development and testing may require reconsideration, however, are lines of research that require more investment of time and funding in design and development of the technology (see Enock & McNally, 2013; Nilsen, Riley, Heetderks, 2013; Riley, 2012; Kumar et al., 2103a). Software development, particularly for applications that are multifaceted in terms of the functionality (e.g., data

collection, skill demonstration, supervision and coaching of skill utilization) can be quite expensive, costs that may be best served by an iterative development or proof-of-concept approach (see Comer et al., in press; Gulbranson & Audretsch, 2008; Jones et al., 2013; Silva, Allen, & Traystman, 2009, for reviews). That is, rather than investing the entire technology budget upfront to develop the final delivery vehicle that is initially envisioned, a more agile and responsive development and testing process borrowed from such representative fields as software development and engineering may be ideal (see Boehm, 2002; Highsmith, 2000; Phillips, 2004, for reviews). Such an approach characterizes one in which the research process begins with what is essentially a prototype that is then tested and continually refined until the design and architecture of the final product is achieved (also see Enock & McNally, 2013, for a discussion of an iterative approach to development, testing, and practice). Importantly, the prototype in this model should include the key features or functionalities of the envisioned product; however, those functionalities may be achieved via more basic and less expensive systems.

For example, if the ultimate, envisioned platform includes daily assessments of specific aspects of child, adolescent, and/or family behavior, investigators may be inclined to use the start-up period of a grant to invest in the fully developed user interface (e.g., website), including programming the questions, response options, and decision-tree that the software utilizes to tailor question number and order, as well as the transmittal process by which the software sends and receives information from the client (i.e., user) to the therapist (i.e., server) sides of the system. The recommended approach, however, suggests at least initially capitalizing on available systems (e.g., commercially available survey programs) in order to assess whether the conceptual framework and associated functionality of the technology is performing as expected (e.g., enhance therapist assessment of client progress beyond the treatment setting and, in turn, better tailor the treatment process to the needs of the client). If the answer is “no”, then this prototype approach, particularly in a pilot phase, affords greater flexibility for determining and testing how the conceptual framework and/or functionality should be modified to better achieve the desired aims, rather than come to these conclusions several years into or at the conclusion of the research process.

“Testing” in this proof-of-concept or prototype approach may encourage investigators to think somewhat differently about other aspects of the research design process as well (see Chumbler, Kobb, Brennen, & Rabinowitz, 2008; Enock & McNally, 2012; Grigsby & Bennett, 2006; Kumar et al., 2013a; Nilsen, Riley, Heetderks, 2013; Riley, 2012, for reviews). For example, a randomized control trial may remain the gold standard and the ultimate test of the final delivery vehicle and its impact on child and adolescent treatment outcome. Yet, earlier testing of the prototype may encourage investigators to look back to the field’s historical roots in behavioral theory and analysis to consider models, such as a multiple baseline design, that provide critical feedback about not only the potential role of technology in treatment outcome, but the feasibility and usability of the technology in the hands of the clinician and the clients that they serve (see Chumbler et al., 2008; Grigsby & Bennett, 2006; Kumar et al., 2013a for reviews). If consumers, in other words therapists, children, and families, do not feel comfortable using the technology that is designed and tested in the course of a line of research and, in turn, do not utilize it, technology has little hope to address the challenges that facing the field of children and adolescent mental health.

Notably, this iterative process (i.e., design, test, modify, repeat) will likely extend the formative stages of the design and development process and, in turn, the research process. However, such a staged approach will also heighten the level of confidence in the features, functionality, feasibility, and usability of the delivery vehicle and functionality that ultimately reaches therapists and their clients. With this extended time frame in mind, however, one thing that investigators can do to ensure that they stay current is ensure that

the functionality is programmed in way that it is potentially transferrable to emerging technologies as well. Such anticipation in child and adolescent outcome research likely necessitates a strong collaboration, if not true partnership, between researchers, consumers, and technologists.

3. Collaborate with Technologists and Consumers with the Aim of Developing and Testing Sustainable Applications

Even a cursory review of available mental health relevant applications suggests that many developers of service-related applications likely have relatively little understanding of the theory or rationale guiding the core components of evidence-based treatment. This example has been used before, but will be presented here again because it aptly highlights the disconnection between evidence-based treatment and many of the mental health applications most widely available to consumers (see Jones et al., 2010; 2013, for reviews). For those trained in behavioral parent training (BPT), the standard-of-care for early-onset disruptive behavior disorders, time-out is a critical component of the treatment and the primary strategy for reducing noncompliance, as well as more severe disruptive behaviors that stand to compromise the child's or another's safety or the potential to damage property (see Reitman & McMahon, 2012, for a review). With this in mind, it is perhaps not surprising then that application developers have seized on the critical relevance of time-out for child behavior management and, in turn, now provide an assortment of time-out application options. Such options include an application that lets the consumer (i.e., the caregiver) program the child's name and age, then the application tells the caregiver the length of time the child should stay in time-out (i.e., some BPT programs calculate the length of time-out by the child's age). Other time-out applications provide caregivers with a timer and an alarm that sounds when the time-out period has ended. Yet, those who are trained in and use BPT are acutely aware that keeping track of time is unlikely to be the biggest challenge of time-out for families, particularly those families of children with a disruptive behavior disorder. Rather, challenges of time-out typically include a child refusing to go to the timeout chair in the first place, a child continuing to engage in disruptive behaviors while in the time-out chair, and/or a child refusing to leave the time-out chair when the time out period has expired (see McMahon & Forehand, 2003, for a review). The widely available time-out applications, however, provide little or no guidance to caregivers regarding navigating these much more common challenges.

To better inform the range of technology-delivered or enhanced interventions available to children, adolescents, and families, then investigators must better situate themselves at the core of the design and development process. In order to do so, investigators must cultivate partnerships that extend beyond clinical psychology to related fields, such as public health, but those that extend beyond academia and research to industry as well (see Chambers, 2011; Kumar, Nilsen, Pavel, & Srivastava, 2013b; Nilsen, Riley, & Heetderks, 2013, for reviews). Given the popularity of technology development at this point in time in popular and consumer culture, potential industry partners are not difficult to find. This is particularly true in certain areas known for growing pioneers in the technology industry; however, even in smaller, less urban areas, developers are plentiful, offering seemingly reasonable rates to move a project from idea to prototype to market. Yet, what is more difficult to ascertain from the websites of these technology development firms is the extent to which they have experience collaborating with those in service-related fields (e.g., health care, education, military) with the aim of developing sustainable applications that effectively serve the need of real-world consumer groups.

Accordingly, an ideal industry partner is one who has experience with successful interdisciplinary collaboration, establishing and implementing procedures for designing and using the technology based on the unique needs of the target consumer, and transporting the

technology into sustainable real world application. One question that sometimes arises in ascertaining such qualifications is the extent to which a particular technologist or firm has experience with the precise platform that is the focus of the research (e.g., smartphone application for mental health service delivery). Yet, what is important to remember is that training in technology and technology development skills are not necessarily or typically platform dependent. Instead, industry partners who have been successful in bringing innovative ideas to design, development, and then to market have likely worked with a range of technologies and a range of collaborators across industry, health care, and even research. It is precisely through this broad range of transferable experience that technologists can serve a vital part of the collaborative investigative process, with the goal of moving the conceptual framework to proof-of-concept and, ultimately, to the realities of front-line practice.

Considering the realities of front-line practice is the second critical piece of this recommendation. The topic of the human interface with technology is one of much discussion among academics and industry leaders in technology and related fields. Perhaps, central among the factors highlighted to date is the goal of “ubiquitous” technology or technologies that “weave themselves into the fabric of everyday life until they are indistinguishable from it” (Weiser, 1991, p. 94). Essentially, ubiquity relies on what has been called a human-centric approach to design or one in which the cognitive, developmental, and social characteristics of the intended consumer are the focus of the innovation, rather than the device (Bar Cohen & Braezel, 2003; Breazel, 2002; Breazel et al., 2006; Schybergson, 2013).

Importantly, some may consider the prospect of a human centered design approach for services work with children and adolescents much easier than for other target populations, given that the target consumers of research are a generation who have lived in a world in which technology has always been a predominate force in their everyday lives. For example, McBride & Neif (2011) recently noted in the most recent online version of their “Mindset List” that the 2016 class of college graduates “was born into cyberspace and they have therefore measured their output in the fundamental particles of life: bits, bytes, and bauds”. To this point, youth have demonstrated a propensity for seeking a range of information via the technology, including health information (see Skinner et al., 2003; Gass, 2013; Havas et al., 2011, for reviews). As such, children and adolescents who are the focus of evidence-based treatment outcome research are likely to be increasingly more comfortable and experienced with engaging in and utilizing emerging technology than any other consumer of mental health care (Richardson et al., 2010). As such, the diffusion of technology into our service delivery models is unlikely to be a difficult sell to our child and adolescent clients and, in fact, some suggest may increase interest and engagement in services (Gass, 2013; Mitchell & Gordon, 2007; Richardson et al 2010). With this context in mind, child and adolescent clinical outcome research may be ideally, if not uniquely, well situated for deploying technology-delivered or enhanced services to clients.

Of course, children and adolescents also have parents or other caregivers accompanying them to appointments and through the treatment process, as well as providers who also need to be trained to comfortably and reliably use the technology enhanced aspects of the intervention approach. Of note, some research to date suggests that providers generally have positive attitudes toward computerized intervention programs (Stallard, Richardson, & Velleman, 2010; also see Comer et al., in press; Grealish, Hunter, Glaze, & Potter, 2005; Greenberg, Boydell, & Volpe, 2006, for reviews). Yet, investigators must continue to keep the needs and preferences of the intended consumer groups, including therapists, as well as children, adolescents, and caregivers, at the forefront of research on emerging technologies if research findings are going to realistically have a chance of impacting front-line practice.

For example, parental involvement in treatments for children and adolescents varies depending on the targeted disorder and treatment program; however, parents are typically involved in treatment to some extent, ranging from serving as more of a coach in the child's treatment process (i.e., a model more typical of treatments for internalizing disorders) to a partner in or focus of the intervention (i.e., a model more typical of treatments for externalizing disorders) (see Forehand, Jones, & Parent, 2013, for a review). Depending on age, technology may be more or less a part of caregivers' daily lives. Accordingly, assessing comfort with and access to technology is critical in considering the extent to which technology can aid to overcome the aforementioned challenges in child and adolescent mental health, rather than exacerbating these challenges. For example, older parents or grandparents serving in caregiver roles may have less familiarity or comfort with technology and, in turn, be less inclined to engage in a treatment that has a technology-enhanced aspect to (e.g., smartphone-enhanced treamtment), let alone one that is driven by technology entirely (e.g., a web-delivered prevention or intervention program).

In addition to age, other aspects of therapists' and clients' sociocultural context are important factors to consider in human centric design as well. For example, the potential for technology to enhance the reach and impact of mental health services for rural providers and the families that they serve was mentioned above and has been discussed elsewhere as well and so will not be discussed further here (see Fahey, Day, & Gelber, 2003; Nelson & Bui, 2010; Nelson, Bui, & Valasquez, 2011; Nelson & Valasquez, 2011; U.S. DHHS, 2013, for reviews); however, the education and income levels of parents and other caregivers must also be considered. Those with higher levels of education are going to have more experience with technology, which continues to be woven into academic curriculum from preschool to graduate education. Income may not only determine experience with technology, but accessibility as well. For example, higher income caregivers (who are also more likely to have more education) may own multiple platforms, so the design and development phase of technology-delivered and enhanced approaches may need to consider how the program materials will be accessed and how they will appear (i.e., the interface, usability) from different devices (e.g., accessing a web-based program via a desk-top computer vs. tablet vs. smartphone).

As noted earlier, lower income consumers are less likely to own technology at all. If they do own technology, however, industry data suggest that they are increasingly represented among those who not only purchase, but rely on smartphones particularly for functions beyond telephone calls and text messages, given the relative cost-effectiveness of using smartphone platforms to access the internet, send and receive email, and even access television shows and movies (see Duggan & Smith, 2013; Smith, 2013; Zikuhr, 2013; Zickuhr & Smith, 2012, for reviews). In spite of the advantage of availability and uptake, the limitations of smartphones must also be considered, particularly when thinking about smartphones as a mental health service delivery vehicle for children, adolescents, and their families. For example, smartphones have a relatively small screen (e.g., if doing an assessment, the screen may display only one question at a time) and a small and sensitive keypad (which may be more difficult for users with visual or dexterity limitations). As such, smartphones may be an example of a delivery vehicle better equipped for technology-enhanced interventions relative to interventions that intend to rely on technology alone.

4. Test the Impact of the Technology, but (Re) Consider the Expected Outcomes

Once the technology-delivered or enhanced approach is developed, there will be a test to demonstrate its efficacy (i.e., does it impact the predicted mechanisms and processes, as well as outcomes, as hypothesized by the conceptual framework), then the work to demonstrate its capacity in the field. The question about efficacy is one worthy of serious consideration, however, particularly before designing a study relying on the traditional standard of

treatment outcome research to test a technology-delivered approach (see Chumbler et al., 2008; Enock & McNally, 2012; Frueh et al., 2000; Frueh, Monnier, Elhai, Grubaugh, & Knapp, 2004; Grady et al., 2011; Richardson et al., 2009, for reviews). That is, typically in randomized control trials there is a comparison of the proposed treatment (i.e., in this case the technology-delivered or enhanced version) to some type of control group, whether it is minimal intervention or wait-list control or some other iteration. The goal in such studies, of course, is to demonstrate that the experimental treatment group evidences statistically significant improvements relative to the control group, improvements that are also considered clinically significant as well (Jacobson & Truax, 1991; Kendall, 1999; Kendall & Grove, 1988).

The question then becomes in technology and services work: What is the control group? Whether technology is enhancing or replacing the established empirically supported treatment, often an established evidence- and clinic-based program, one option is that the established program is the control group (e.g., technology-enhanced behavioral parent training versus standard behavioral parent training) (Jones et al., 2010; Jones et al., 2013). Although such an approach seems obvious in some ways, caution is warranted in thinking about the expected outcomes and this is where circling back to the conceptual framework behind technology as a delivery vehicle again is important: What are the intended functionalities of the technology and how is the impact of these functionalities on treatment outcome measured? Is the expectation that technology will boost the efficacy of the standard evidence-based approach and, if so, what are the hypothesized mechanisms through which technology is achieving these aims? For example, skill practice and generalization are generally considered critical to achieving statistically and clinically significant treatment effects. Perhaps it is hypothesized that technology will bolster realistic opportunities for skill practice in session (e.g., virtual reality) or generalization via guided practice out-of-session (e.g., videoconference coaching). If so, then the hypothesis may be that the technology will in fact boost the targeted skills and, in turn, treatment outcomes.

Alternatively, perhaps the guiding conceptual framework is that technology is not intended to enhance treatment effects relative to an established evidence-based approach, but rather to yield equivalent outcomes. With such an approach, the conceptual model may suggest that technology will have some added value on other important fronts (e.g., less need to devote time, training and supervision to specialized training, efficiency of data collection regarding client progress and outcomes, less therapist and family time in session and/or in treatment) (e.g., Ekblad et al., 2004; Khanna & Kendall, 2010; also see Comer et al., in press; Fahey, Day, & Gelber, 2003; Funderburk et al., 2008; Jones et al., 2013; Kendall, Khanna, Edson, Cummings, & Harris, 2011, for reviews). In other words, the goal may not necessarily be to improve treatment outcome per se, but to improve the reach and/or efficiency of service delivery and, in turn, broaden the potential impact of treatment beyond the four walls of the therapy session.

Finally, some may argue technology-driven service delivery models should not be expected to be better than or even equivalent to standard evidence-based treatment approaches. Such an approach would contend that the manuals that result from time- and resource-intensive programs of research are doing relatively little good beyond university research and training clinics if they are not being utilized at all or utilized as intended in community practice settings. As such, technology in this case affords the opportunity to offer standardized service delivery to children and adolescents who may otherwise not receive state-of-the-field prevention and intervention programs due to lack of availability in their area and, in turn, receive either no care at all or substandard care when providers do not have the time or resources to maintain fidelity to the treatment manual (see Graeff-Martins et al., 2008; Mohr, Cuijpers, & Lehman, 2011; Nelson & Bui, 2010, for reviews). Technology, in turn,

may not entirely make up for this gap in service provision, but the hypothesis in such a case may be that technology has the potential to offer enough of the core elements of treatment to yield a clinically significant change in child and adolescent psychosocial functioning. Many would agree than some improvement is better than no improvement at all, which would particularly be the case in areas where there are a dearth of providers in child and adolescent mental health and/or where evidence-based practice can not be or is not yet a priority (e.g., rural areas) (see Fahey, Day, & Gelber, 2003; Nelson & Bui, 2010; Nelson, Bui, & Valasquez, 2011; Nelson & Valasquez, 2011; U.S. DHHS, 2013, for reviews).

A final related, but distinct point is worth noting before moving to the next recommendation. That is, what is the scope of outcome research that needs to be conducted before there is confidence that a specific platform (e.g., web-delivered intervention) achieves the intended outcome (e.g., symptom remission) for a specific type of disorder (e.g., internalizing) or for child and adolescent mental health issues more broadly as well. To draw upon behavioral parent training again as just one example, the field is characterized by a collection of behavioral parent training programs, each of which shares a common foundation in theory and associated treatment techniques (see Jones et al., 2013; McMahon & Forehand, 2003; Reitman & McMahon, 2012, for reviews). Accordingly, if for example a technology-enhanced version (e.g., via the web or smartphone or virtual reality) is compared to one of the standard versions in this group and the technology-enhancements have the intended impact (e.g., enhance engagement, improve skill generalization, boost treatment outcomes), then the question becomes whether it necessary to test the technology-enhancements with each of the other programs as well (see Jones et al., 2013, for a review)? Or, would there be relative confidence that given the common theory and techniques the technology-enhancements should have a similar effect with the other programs too? Similarly, if CD-ROM technology is proven efficacious for the treatment of childhood anxiety for one program (e.g., Coping Cat), does it need to be tested with other anxiety programs as well or is the Coping Cat data sufficient to say the approach works and should work similarly for other anxiety programs with a similar foundation in theory and content (Khanna & Kendall, 2008; also see Kendall et al., 2011). These are questions that have yet to be answered in child and adolescent clinical services research, as well as services research more broadly, but are important to consider, particularly with regard to the potential cost and cost-effectiveness of technology as a service delivery vehicle.

5. Examine the Cost-Effectiveness of the Technology-Delivered or Enhanced Approach

The prevalence of mental disorders among youth worldwide is estimated to be 20% (World Health Organization, 2001). In the U.S. alone, one-fifth of children, up to 15 million, have a diagnosable disorder (Burns, Hogwood, & Mrazek, 1999; Kazak et al., 2010). Disorders of childhood affect a wide range of youth functioning, including family and peer relationships, as well as academic performance and persist into adolescence and adulthood, exacerbating the risks for individual disability and impairment (see Costello, Foley, & Angold, 2006; Fleitlich & Goodman, 2001; Graeff-Martins et al., 2008, for reviews). In addition to the psychosocial costs, rates of childhood disorders fail to reflect the far-reaching economic effects for families and society, with some estimates putting treatment costs for children in the U.S. alone at more than $11 billion dollars per year (Eyberg, Nelson, & Boggs, 2008).

With these costs in mind, there is certainly room for technology-delivered and enhanced mental health interventions to reduce the costs of psychosocial suffering for children, adolescents, and families and associated economic costs as well (see Frueh et al., 2000; Hilty, Bourgeois, Nesbitt, Hales, 2004; Kennedy, 2005; Richardson et al., 2009; Shore, Brooks, Savin, Manson, & Libby, 2007, for reviews). To this point, Tate, Finkelstein, Khavjou, and Gustafson (2009) highlight that cost-effectiveness is given as a primary rationale for developing service-based internet-delivered interventions in particular;

however, they also caution that only 8 of the 420 studies published on internet-delivered interventions in particular from 1995 to 2008 actually reported economic data. Of these, the authors noted “many were lacking comprehensive analyses” (Tate et al., 2009, p. 40). Although their analyses focused on internet-delivered interventions in particular, the relative lack of attention to cost and cost-effectiveness research leaves relatively little to be said regarding the the feasibility or sustainability of technology-delivered or enhanced service delivery models.

Thus, there is a unique opportunity in the field of child and adolescent clinical psychology to take a lead on this front by examining the efficacy of technology as a treatment delivery vehicle, as well as the incremental cost-effectiveness afforded by the integration of technology. Such examination and the resultant data would likely prove valuable to policy-makers and funding sources with increasingly limited resources to devote to mental health, let alone child and adolescent specialty services and providers in particular. For example, some work in the treatment of childhood anxiety suggests a CD-ROM version of an evidence-based treatment program could yield cost savings up to one-third compared to standard practice (Khanna & Kendall, 2008; also see Comer et al., in press, for a review). One framework to guide such analysis breaks costs down into essentially two categories, sunk or start-up and implementation (see Tate et al., 2009, for a more thorough discussion of cost data and analysis).

Briefly, sunk or start-up costs are generally considered those costs to develop the functionality that will be used to deliver the intervention component, costs that include programming for example (Tate et al., 2009). These sunk or start-up costs are essentially those that would occur for the investigative team developing and testing the technology, but not necessarily recur for the agencies, providers, or the children, adolescents, and families using them. The greatest cost of delivery for providers and clients in front-line mental health service settings, however, would be the implementation costs (Tate et al., 2009). Implementation costs for agencies, providers, and families, depending on the functionality of the delivery vehicle, may include the cost of the platform (e.g., the computer, smartphone, tablet) and service plans (e.g., smartphone data plan), any sort of licensing or utilization fees to utilize the technology-delivered or enhanced aspects of the program (e.g., do the developers charge each agency a multi-use licensing agreement or is the program free?), the maintenance of the program interface (e.g., agency server space, privacy and security compliance for incoming assessment information or data), and the “cost” of therapist and family time to utilize the technology-enhanced aspects of the treatment program (e.g., how much additional “time”, if any, is the therapist spending with the family between or within sessions via the technology?).

Moving forward, it is critical to collect the start-up and implementation costs of technology-delivered and enhanced interventions, an aim equally important, if not more so, than collecting treatment outcome data. This is particularly true if the field is looking to and even relying on technology as a worthwhile investment toward overcoming, rather than exacerbating, the primary challenges limiting evidence-based service delivery for children, adolescents, and their families in front-line service settings. However, the potential cost-effectiveness of technology should not be used as a rationale for technology-delivered or enhanced services research if the research infrastructure is not established or in place to examine the costs, as well as cost benefits, of such an approach relative to the standard delivery model. It is truly only through the collection of such cost data that the potential sustainability of technology-delivered and enhanced approaches to child and adolescent clinical services work can adequately be examined and considered. In addition to cost and cost-savings, sustainability is also determined by consideration of the real world clinical

impact of technology delivery on ethical and privacy issues, which is the last recommendation that will be considered here.

6. Consider Ethical and Privacy Issues Inherent in Technology Delivery

As with other aspects of the use of technology in services research, the field is progressing far more quickly than advances in relevant ethical and practice guidelines (Novotney, 2011; also see Nelson, Bui, & Vasquez, 2011; Nelson & Vasquez, 2011; Reed, McLaughlin, & Milholland, 2000; Richardson et al., 2009). The potential ethical issues related to technology as a delivery vehicle in mental health more broadly are numerous and include cross-state licensure (e.g., therapist using technology to remotely supervise another therapist or conducting therapy with a patient in another state), standard-of-care (e.g., emergency protocols when a client is not physically in the same room as the provider or there is no "provider"), privacy and security (e.g., use of secure networks, encryption of emails, confidentiality in group chat rooms), and feasibility (e.g., training both providers and clients in the use of technology).

The field of child and adolescent clinical psychology is certainly not immune from any of these evolving ethical and privacy issues. For example, if a trainer is training or supervising another therapist's case remotely via some type of videoconferencing connection (see Comer et al., in press; Ekblad et al., 2004; Funderburk, Ware, Altshuler, Chaffin, 2008; Jones et al., 2013, for reviews), what security measures must be in place to guarantee a family's confidentiality? How does the therapist who is in training assess a family's understanding of the remote supervision and its implications for the broader range of providers who may be involved in their case? Who regulates the technology to ensure that it is being utilized in a manner that maximizes the security of data and images obtained from remotely observed sessions?

Similarly complicated issues arise when we think about families interfacing directly with technology, including issues of risk and safety (see Turvey et al., 2013, for a review). Prime examples of risk in child and adolescent specialty services in particular, include suspected child maltreatment and/or suicidality or homicidality in the child or adolescent client or their family members who may be accompanying them through the treatment process (e.g., Foster & Whitworth, 2005; Godleski, Nieves, Darkins, & Lehmann, 2008). For example, how will the potential for self-harm or harm to others be assessed via technology? Will an increased reliance on technology increase the probability that signs of risk will be overlooked or missed? Finally, will opportunities to intervene and thus protect the client, family member, or some identified "other" beyond the family structure be reduced in technology-driven mental health approach? Will these issues be most salient for those technology-driven interventions that substantially decrease or replace the provider and, in turn, potentially lose the value added by trained clinical assessment and judgment?

Leaders in mental health and across our governing and guiding agencies are at work on these very complicated issues, which must continue to be considered and incorporated into research questions and designs as technology-delivered and enhanced services research continues to evolve (see American Psychological Association, 2011; American Telemedicine Association, 2009; Nelson & Valadquez, 2011, for reviews). For example, digital traces or the security of data captured by technology is now at the forefront of some of the most heated and sensitive public debates of our time and investigators must pay attention to the discussions if the field is going to ultimately safely and effectively utilize technology to better meet the needs children, adolescents, and families. Notably, the opportunities for breaches of confidentiality proliferate when one considers even the most basic technologies that have the focus of investigation (e.g., text messages, email), let alone those that may arise if investigators are not cautious regarding the potential implications of

more advanced functionalities as well (e.g., message boards, electronic surveys, videos of home practice, video-based online sessions). Most believe that the potential benefits of progress on this front outweighs these potential risks, but this only remains true if ethics and privacy, like feasibility and sustainability, are central to the investigative process examining technology-delivered and enhanced approaches and the potential implications for front-line providers and their child and adolescent clients.

CONCLUSIONS

In summary, child and adolescent clinical psychology has evolved dramatically since its inception as a specialty area of research and practice. The field has the potential to offer evidence-based treatments for a host of disorders and presenting issues to children, adolescents, and their families, as well as training programs and models devoted to an evidence-based practice approach. Yet, the reach and, in turn, potential impact of training and service delivery is significantly challenged, a state-of-the-field that has led to consideration of a host of solutions for bridging the gap between research and practice. Technology has been at the forefront of such recommendations for quite a while; however, the discussions of possibilities seem to far outweigh the research necessary to support the efficacy and effectiveness of such an approach.

Accordingly, the field is quite literally upon a new frontier where the rich history and foundation in evidence-based research and practice must meet and adapt to the fast paced innovations of emerging technologies. This frontier holds immense promise, including burgeoning opportunities to overcome some of the most challenging issues in the field. With opportunity, however, there is responsibility. These include remaining true to the established pillars of theory and research that are the guiding foundation of the field, while also being practical and fiscally responsible in consideration of any technology-delivered or enhanced interventions for children, adolescents, and their families. The recommendations provided in this article are intended to spark further discussion, but more importantly to guide and foster future directions in research which capitalize on advances in distinct, but increasingly related fields of public health, psychiatry, technology, computer science, and engineering. These recommendations and the research that emerges from them, of course, will need to continue to adapt and evolve with the advances in emerging technologies, as well as changes that occur as the field responds to issues such as privacy and data security. Future Directions in treatment outcome research with children and adolescents, however, hinges on researchers remaining at the center of the evolution in design, development, and empirical inquiry that is critical to the eventual reality of technology as a service delivery vehicle that has the capacity to bridge the research to practice gap and, in turn, to more adequately serve children and adolescents, as well as their providers, in front line service settings who most need and will benefit from continued advances in the field.

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