COMPUTER TECHNOLOGIES IN PSYCHOTHERAPY AND SELF-REGULATION

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Abstract. Computer technology is a process that uses a set of methods and means for implementing the operations of collecting, recording, transmitting, accumulating and processing information through computers and computer networks. In recent decades, computers and computer networks have played an increasingly important role in the development of humanity, including the use of psychotherapy. Our review describes research on the prospects of the use of computer technology in the provision of psychotherapeutic assistance for and self-regulation of the mental state of users. The results of this research can serve as a basis for development and research in further scientific studies in Russia.

Key words: virtual reality, Internet, computer technologies, cognitive-behavioral therapy, mental disorders, psychotherapy, self-regulation, smartphone.

Computer (information) technology is a process that uses a set of methods and means for implementing the operations of collecting, recording, transmitting, accumulating and processing information through computers and computer networks [6, 13, 15]. For more than four decades, they have been an important component not only of the technological progress of mankind but also of everyday life. The widespread use of mobile devices, personal computers and Internet-connectedness contributes to targeted communication with clients or patients as well as self-control of their physical and mental states [5]. For example, a smartphone is capable of launching software applications, many of which can now perform a number of similar functions to psychological and medical interventions: pulse measurement, self-esteem of emotional state, psychodiagnostic testing, instruction during relaxation exercises, etc. [23]. Neil Harbisson is a

cyborg activist who has a congenital color vision deficiency. With the help of a special device, he can perceive the surrounding colors in the form of sound waves [95]. He participated in the development of this device, which indicates the demand for computer technology as a means to regulate peoples' own mental processes and improve their quality of life. Computer technologies play a special role in medicine and are an important component of devices for diagnosis and therapy, and in recent years, the development of neural networks that can potentially replace doctors in diagnosing and controlling the effect of therapy has been actively carried out [59, 60]. Technical capabilities have now made it possible for a number of psychological and psychotherapeutic procedures to be done outside of the therapist's office, and there are certain economic benefits for both psychologists and clients. As a rule, psychotherapeutic programs are quite long and consequently expensive. This may reduce the availability of psychological assistance for the general population [20, 26]. The above factors point to the trend toward the spread of computer technology in the field of psychological and psychotherapeutic intervention as well as the increase in the amount of support for self-help and self-regulation of the users' mental state [11], which could become an important supplement to existing methods of psychological support.

Psychoeducational programs. Nowadays the market of applications for smartphones and desktop computers includes a large number of options that allow you to monitor and evaluate your mental state. Such programs are aimed at increasing users' level of awareness and self-control of their emotional state and stress, and some promote personal growth and provide training in cognitive skills [47, 48, 63, 71, 79, 93, 94, 96−99]. Psychoeducational interventions are used to provide and explain information about the main provisions of the psychotherapeutic modality and the viewpoints, causes and mechanisms and symptoms of the disease to a client. Particularly, in cognitive-behavioral therapy, psychoeducation holds a special place in the structure of the therapeutic program,

and psychoeducation itself has a significant therapeutic effect [10]. At the same time, such training tools can be used without the direct participation of a psychotherapist or psychologist and can be attained through the use of books, brochures, information resources, videos, etc. A similar strategy is often observed in computer programs for self-regulation [93, 97, 99]. There have also been studies of computer programs focused on psychoeducation as a leading tool to support patients and clients.

In a series of studies by Andrews et al. [74, 88], computer programs designed for the treatment of depressive and anxiety disorders using the cognitive-behavioral approach were examined. The methodology of studies included video tutorials for subjects' psychoeducation and homework as well as the possibility of clinical observation by a psychiatrist and a clinical psychologist. The program consisted of six lessons conducted over 8 weeks. The lessons were compiled as a comic paper about the story of a character named Jess who had depression. Her story helped the participants learn how to cope with their symptoms and showed them that they could apply the same approaches to their own lives. At the end of each session, participants had to do corresponding exercises and review the lesson. Additional resources such as information on self-confidence skills and sleep hygiene, as well as stories from the previous participant's experience, were available through the program. The study groups included patients with mild to moderate depression, generalized anxiety, panic disorders and social phobias. Subsequently, the authors compared the computer and mobile versions of the program and found no significant differences between them. In addition, both the computer and mobile versions produced positive effects, including the reduction of symptoms.

A similar application was examined as part of the cognitive-behavioral approach used by Wright et al. [90, 91]. Users completed seven lessons in which they observed a character who managed his mental state at home, at work and in

daily communications with other people. Videos were used to illustrate the interactions between the protagonist and other characters and to relate the psychotherapist's comments. Each lesson began with the therapist describing the concept of a cognitive-behavioral approach, then asking the user to apply the concept to the character, and finally asking the user to apply the concept to himself or herself. The lessons focused on identifying, marking and altering automatic thoughts. Users were further encouraged to create activity graphs so that they could determine the degree of skill and enjoyment associated with each activity and assess whether a change in the amount of time spent on that activity might be beneficial. The program concluded with a lesson on discovering and changing patterns (the basic beliefs and assumptions that determine how a person represents himself or herself). In general, the authors noted the same degree of effectiveness as conventional cognitive-behavioral therapy applicable to depressive disorders.

Ahtinen et al. [17] examined a program based on the principles of Acceptance Commitment Therapy (ACT). The user can do exercises while reading or listening to materials. The program contains audio and video materials and suggests separate tasks designed to combat states of stress, anxiety, depression and sleep disorders. The authors of the study noted an increase in life satisfaction levels and a decrease in stress levels of the subjects. However, a small sample (15 subjects) and unrealized principles of randomized controlled research were limitations of this study.

The studies of Rizvi et al. [78, 79] were devoted to the possibility of using a mobile application as a coaching device to strengthen skills in the framework of dialectical behavior therapy. Dialectical behavior therapy is a field of psychotherapy that was established within the framework of a cognitive-behavioral approach where the principles of a directive and structured therapeutic program play an important role. In turn, it requires that clients and patients gain additional tools to participate in this structured program. Both studies involved patients with

borderline personality disorder and associated behavioral disorders that included substance abuse and suicidal behavior. The created application helped users to reinforce, improve and apply skills to regulate their behavior and emotions. It was used as a supplement to the ongoing program of dialectical behavior therapy and was not an independent factor of influence on patients. Although the authors mentioned a number of limitations of their research — in particular, users' decreasing interest of the application over time and the inability to identify the leading factor of therapeutic impact between the components of the therapy complex—there were also positive aspects of the application. Participants mentioned greater accessibility, convenient use and the availability of support and assistance at the needed time. The borderline disorder and substance abuse groups showed a decrease in emotional stress, depressive symptoms and substance addiction. The group with suicidal behavior also had a decrease in emotional tension, catastrophization of their own feelings and craving for self-harm.

Mental health monitoring programs and applications. Several applications offer the ability for their users to evaluate their emotional state. Studies have been conducted to consider the use of such applications by assistance organizations for persons with mental disorders and psychological stress. For example, Australian researchers [62, 66] studied the use of a specially designed mobile phone application that tracks depression, anxiety and stress levels in young people. Data from this app were available to both the subjects and general practitioners. The study found that monitoring the mental state helped subjects increase their level of emotional self-control, identify stressful situations and prepare for those situations. The authors stated that such monitoring could be the first step in psychotherapy and would allow for intervention before mild depressive symptoms begin to progress to a major depressive disorder. General practitioners also noted the positive impact of such a system, as they had an additional tool for

assessing the mental state of their patients with the possibility of providing timely assistance.

Burns et al. [30] studied the technical capabilities of smartphones to predict the emotional states of users. Although the sample was relatively small — eight participants — the amount of data collected revealed certain patterns and demonstrated the positive perspectives of this approach. Patients with depressive disorder were selected as subjects and included in the study based on an interview with a clinician and the inclusion of the appropriate psychodiagnostic procedures. In addition to assessing the depressive state itself, other emotional states were also assessed in the study, including anxiety level. All participants were included in the study after several interventions that included participating in psychoeducation and behavior management lessons through a website, phone coaching and working with a coach. The preparation of self-reports on the condition and the environment of the participants, which they prepared in a special application, was the main content of the intervention through the smartphone. Moreover, the app used data collected from sensors pre-installed on the phone that allowed it to mark the environment and topography (which was used to create a mood map) and collect the user's physiological indicators such as heart rate and motor activity. Predictive models of emotional states were formed based on the comparison of data from sensors and emotional states mentioned by subjects in self-reports and psychodiagnostic scales. The authors noted the high number of technical difficulties they encountered during the study, but they see interesting prospects for the future use of such applications in the therapy of depression. Throughout the study, participants noted relief of depression symptoms; the authors attributed this to the training that participants completed, as well as the development of self-regulation, which was possible due to the use of the application. Moreover, more accurate predictive models can be useful for creating an alert system and implementing timely interventions to exacerbate depressive symptoms. Bakker et

al. made an interesting observation in their review paper [22] that intervention in the form of self-help and self-regulation was significantly more effective when it occurred with a non-clinical group of subjects than in subjects with an already developed mental disorder clinical presentation. From this it is concluded that applications for self-regulation can serve as a preventive means to preclude the development of mental disorders [22, 51].

Applications for behavior regulation. Review works on applications aimed at changing behavior in order to maintain or improve mental health, note a significant increase in such applications among all programs for mobile devices [22, 100]. Average users check their phones more than 150 times a day, which makes it possible to use smartphones to generate, reward and maintain certain behavioral stereotypes associated with their use [22]. Bakker states the possibility of using gamification elements of computer gameplay to increase user motivation [22]. Zhao et al. [100] reviewed seven studies in this area. Most often, these studies related to depression and depressive symptoms [18, 30, 68, 89] as well as alcohol addiction [50, 52, 56]. Studies showed a different efficiency for depressive disorders and alcohol addiction syndrome. While a decrease in the depressive background was noted in the short term for depressive symptoms in all the studies reviewed (but a decrease in the achieved effect in the long term), the effect was either less or not observed at all in alcohol addiction.

The review paper by Choo et al. [32] presents the results of an examination of articles from 2001 to 2017 that were devoted to mobile applications for behavioral control of alcohol consumption in people with alcohol addiction in Australia. The authors concluded that, despite the growth in the number of such applications, convincing scientific evidence of their effectiveness is insufficient. The authors noted some positive aspects in the use of applications as an additional means of influence but that they are not able to replace other treatments. The authors also raised an important point related to the legislative regulation of such

applications, which currently do not belong to the category of medical equipment as they do not meet the relevant requirements for efficiency and safety.

A significant number of applications and research papers related to them regard eating behavior and weight control [24, 58, 83]. In particular, Kolar et al. [58] presented a protocol of a study on the possibilities of using a smartphone application when working with adolescents suffering from anorexia nervosa. These studies consider the prospects of such applications in order to control the medical consequences of overweight and obesity, which are of significant importance for the prevention of somatic diseases and eating disorders such as anorexia and bulimia as well as psychosomatic medicine [55].

Remote therapy. Information technology has allowed the process of communication between the therapist and the client to extend beyond a personal visit to the office. Basic and supportive interventions can be carried out through phone calls, video calls and even e-mail and SMS [67, 87]. Many research and review papers are devoted to the possibilities of using computerized or cognitive-behavioral Internet psychotherapy (cCBT) [20, 21, 38, 40, 56, 83, 84] or psychodynamic Internet psychotherapy [26, 61] as an alternative or supplement to face-to-face therapy. Computerized therapy is provided with the help of an autonomous computer or web program. It includes an explanation of the psychotherapy model and encouragement when doing homework between sessions and uses active behavioral monitoring and thought patterns. It is conducted by a trained cognitive-behavioral practitioner who usually analyzes the progress and outcomes of therapy. The course usually takes more than 9−12 weeks, including follow-up actions [72]. The possibilities of cCBT application in the treatment of mild and moderate depression, post-traumatic stress disorder and anxiety disorders, including panic and generalized anxiety disorder, were studied most often. A study by Donkin et al. [40] examined the possibility of using a specially designed program for depressive symptoms. It was a cCBT-based program containing

sections on psychoeducation about depression with components of cognitive-behavioral therapy, interpersonal psychotherapy, applied relaxation and physical activity. It allowed users to choose which aspects of treatment they wanted to use and the option to utilize their own tools. Important conclusions of the researchers concerned not only the effectiveness of this program, which was measured by the reduction of the level of depressive symptoms in the subjects, but also the connection between the time spent on the use of the program and the number of completed tasks and modules. This connection was expressed by the fact that the greatest result was achieved by those subjects who used the program more often and more actively followed the instructions.

The authors of the reviews noted the prospects of such technologies, but the results of the meta-analytical study showed a number of limitations. For example, Dedert et al. found that the effect of degree in the treatment of anxiety disorders is more significant than in depression and post-traumatic stress disorder [38]. Arnberg et al. [21] analyzed 54 papers concerning various methods of computerized psychotherapy on the criteria of effectiveness, safety and profitability. The authors found moderate evidence that cCBT has a favorable short-term effect in social phobia, panic disorder, generalized anxiety disorder or mild depression for adults. However, they failed to draw conclusions about the proportionate effectiveness of proven treatments in long-term follow-up, adverse effects, economical efficiency and applicability to children and adolescents.

Spek et al. conducted a meta-analytical study of papers on cCBT for anxiety disorders [83]. As the results of their review showed, its effect in the therapy of anxiety disorders is convincing, and it was most successful when used with the support of a psychotherapist. So et al. also mentioned that depression therapy showed a smaller effect on meta-analysis than that reported in the randomized trials, which were included in the review [83]. However, this effect was greater than in the active placebo group. Another important conclusion may be that such

methods are effective primarily in the short-term time period of about 8-12 weeks, but this effect decreases with longer-term intervention. In addition, the authors believe that the link between the functionality of cCBT as a method used by those with depressive disorders returning to work is less significant than stated in the studies. The question of the differences between computerized therapy and face-to-face therapy remains unresolved, since a sufficient number of comparative studies have not yet been conducted [21]. At the same time, all researchers agree that the development of technologies and the involvement of new ideas in the cCBT implementation can be useful since the cCBT principle has undoubted advantages in the affordability and timeliness of patient care.

Applications for mindfulness practices. Mindfulness practices (mindfulness) are similar to psychotherapy and are one of the most common and actively researched methods used in recent years. Mindfulness refers to the ability to arbitrarily focus on current events and feelings and switch attention from one aspect to another while being aware of the controllability and manageability of the concentration process. Mindfulness therapy is a combination of meditative practices and techniques of modern cognitive-behavioral therapy, developed in the framework of the so-called third wave of cognitive-behavioral therapy. The most developed computerized mindfulness-based interventions include mindfulness-based stress reduction (MBSR) and mindfulness-based cognitive therapy (MBCT). Many studies have shown the positive impact of mindfulness practices on reducing stress, anxiety and depressive symptoms [22, 25, 29, 31, 42, 45]. The study by Economides et al. examined levels of stress, affectation and irritability after brief smartphone use (over 10 sessions). Although the authors noted several limitations of their study related to the selection of a cohort of subjects, they considered the impact on stress levels, affectation and irritability after the application use as positive. A number of review and meta-analytical

works [82, 84] noted the positive impact of the application on reducing the level of stress and anxiety in users.

Smartphone apps, websites and programs that allow practicing mindfulness without the direct supervision of a psychotherapist, that is, on the principle of self-regulation, are also widespread [25, 28, 42, 81, 84, 93, 94, 96−99]. A few years ago, Master Kit tool, which includes a set of computer automated algorithms, was introduced in Russia. It comes in the form of a multimedia simulator and allows the client to detect beliefs that prevent him from achieving his goals or reduce the degree of life satisfaction. Thus, it is assumed that the user must learn how to independently reduce the level of stress, anxiety and depression as well as influence his level of life satisfaction by increasing his mindfulness level [8, 14].

Could automated conversational agents replace the psychologist? Developments in the field of artificial intelligence have not spared the field of mental health. Reviews show a significant increase in the number of mental health and self-regulation applications for smartphones and personal computers. Chat bots are special in this field. Chatbots are computer programs that can become interlocutors for people who practice the process of self-learning [33, 59, 60, 73]. The prospects of such studies are noted in many areas. For example, Ireland et al. [33, 59, 60] studied the use of a chat bot for patients with Parkinson's disease and autism spectrum, and Oh et al. [73] created an empathic chat bot for patients with mental disorders. Woebot service by Woebot Labs is another striking example of a chat bot. This program is based on algorithmized protocols of cognitive-behavioral therapy, which are used in human-bot interaction. A study by K. K. Fitzpatrick et al. [47, 76] involved a group of students with preclinically pronounced levels of anxiety and depressive symptoms. The subjects got brief psychoeducation in the CBT approach, which is commonly used in psychotherapy. Then they were asked to use the Woebot app for two weeks, under the condition that the app could not be a substitute for therapy and with the recommendation that the user seek help in the

case of an emergency. In the results of the study, the authors drew attention to statistically significant improvements in the study group: symptoms of anxiety and depression became less pronounced.

Taking into account the ubiquity of mobile devices, Miner et al. [68] wondered how built-in interactive agents could be useful in organizing assistance for the population. In their study, they examined the four most common dialog agents for smartphones. The authors asked dialog agents simple questions about mental health, interpersonal violence and physical health. The authors concluded that at the time of the study dialog agents were ineffective in providing timely assistance since they often did not consider the addressed questions as signs of mental or physical distress. Nevertheless, some of them did recognize questions pertaining to suicidal risk and recommended that the user should visit his or her doctor. According to the authors, improvements in this area would allow the use of dialog agents as a tool for timely assistance, including psychotherapeutic assistance.

In the previous sections, we have given examples of the possibilities of computer technology as a tool for self-regulation or psychotherapeutic interventions, largely taking over the psychotherapist or psychologist functions. Henceforth, we would like to give examples of the use of computer technology as independent therapeutic methods and techniques.

Biofeedback. Yu. N. Bykov and T. B. Bender [1] studied the effect of external rhythmic stimulation as a type of non-drug therapy based on the principles of biofeedback on the psycho-emotional state and cognitive functions of patients with Parkinson's disease. For this purpose, the authors developed the program for the smartphone or laptop. Patients took 15-minute therapy sessions twice a day for two weeks. In the study results, the authors noted a moderate improvement in cognitive function in subjects as well as a decrease in anxiety. However, no changes in the depressive and autonomic disorders levels were observed.

Virtual reality. The use of virtual reality (VR) in psychotherapy of mental disorders is currently associated with several areas: virtual reality hypnosis (VRH), virtual reality social cognition training (VR-SCT) and virtual reality exposure therapy (VRET). VR is used in the treatment of anxiety disorders, including phobias [49], post-traumatic stress disorder, pain, eating disorders, surgical interventions, burn disease and other disorders [5].

Cognitive-behavioral methods are used for a wide range of anxiety disorders, including phobias and panic, obsessive-compulsive, generalized and post-traumatic stress disorders. The results of clinical studies show the greatest effectiveness of exposure techniques in the treatment of specific phobias in combination with cognitive techniques [7]. Exposure techniques are aimed at developing the ability of the patient to confront the stimuli that cause anxiety or fear in a situation that contributes to the successful overcoming of this fear. Three types of exposures are distinguished—natural (confrontation against the external situation), interoceptive (confrontation against internal stimuli) and imaginal (opposition against the idea or memory). Natural and imaginal techniques are most often applied for the therapy of phobic disorders. However, in recent years, computer technology has begun to take on a special role as another version of the exposure, which combines elements of natural technology and imaginal options — the use of virtual and augmented reality. Virtual reality is a reality completely created with the help of modern computer technologies [5]. Virtual reality uses special position trackers with displays (virtual reality helmets) that dynamically update the user's visible space in the virtual environment. It is important to understand that virtual objects completely replace the real environment of the user. Augmented reality is a variant of virtual reality that combines the real world with virtual elements using computer graphics mixed with the real world in real time. Some experts consider the use of exposure techniques cruel, especially immersion situations (prolonged exposure to a frightening stimulus), which raises the ethical issue of their applicability. In this

regard, it becomes urgent to develop technologies that will combine the effectiveness of exposure techniques with a more acceptable procedure for the patient, and we have found that virtual reality possesses these qualities [2−4, 5, 16, 27, 49, 69]. Botella et al. [27] studied the preferences of a sample of people suffering from certain phobias and suggested a conventional exposure delivery method (in vivo) versus exposure delivered with virtual reality (VR), and 76% of patients chose virtual reality exposure. However, according to A. S. Kuzmina [7], the use of virtual reality has a number of limitations associated with the creation of the immersion effect; one of which is that it is quite dependent on the technical equipment. Less detailed elaboration of the virtual space can reduce the therapy effectiveness. Augmented reality offers the same benefits as VR (i.e., full control over how radiation is administered, easier access to threatening stimuli, no risk of real danger to the patient, ability to transcend reality, privacy), but it can be cheaper than VR because there is no need to simulate the entire environment.

Avatar therapy. Avatar technology is one more interesting field in psychotherapy of mental disorders. An avatar is a digital model or human visual projection in an artificially created reality [85]. As Taylor [85] noted in a study comparing the memories of eyewitnesses about face-to-face communication and avatar communication, the latter has an advantage in reducing the level of distrust, which made it easier for eyewitnesses to engage in dialogue and recall events more openly. The studies [34−36, 43, 45, 53, 64, 65, 75] devoted to the treatment of patients with verbal hallucinosis in schizophrenia and affective disorders showed the opportunities of avatar use most vividly. Leff et al. [64−65] were the first to apply avatar therapy for hallucinations in their studies. The idea of avatar therapy is that verbal hallucinations are perceived as emanating from entities that have a personal identity and speak for a definite purpose and with whom the listener establishes a personal relationship. The authors used the principles of cognitive-behavioral psychotherapy to create a projection of the patient's "voices".

The researchers mention that the dialogue with the "voices" is a useful technique in the treatment of patients with hallucinosis but that talking with an invisible interlocutor is difficult for patients and the therapist. The use of a virtual avatar was intended to solve this problem. The avatar was created at the request of the patient, with the most inherent features suitable for the test "voice". The article [39] describes a clinical case of the successful application of avatar therapy that reduced depressive symptoms in the patient and discomfort from hallucinatory experiences, which improved his quality of life. Craig et al. [34−36] conducted a randomized controlled trial comparing avatar therapy and supportive care in a sample of 150 patients over a 24-week period. The results of the study showed that patients found relief with avatar therapy in as early as 12 weeks, and this effect was persistent for 24 weeks: the stress level due to the "voices" decreased — in some cases the "voices" disappeared, and in others the attitude of patients towards them changed.

In addition to supporting the treatment of patients with psychotic disorders, the avatar therapy approach has been applied to patients with borderline mental disorders of the neurotic and depressive spectrum with personality disorder. Allen et al. [19] examined the possibility of using avatars to diagnose avoidance in patients with post-traumatic stress disorder. The authors noted that the prospects of such technologies can be useful not only as a means of diagnosis but also as a way to overcome the avoidance behavior, which is important in the treatment of anxiety and post-traumatic stress disorders. Falconer et al. [43] examined the prospect of using avatars as an adjunct in the therapy of patients with borderline personality disorder. Although the study sample was small, the authors noted the positive impact of such therapy on patients' development of skills to mentalize their own emotions and behavior, including their reactions to other people. Gordon et al. [53] reported successful practice of the use of avatars in the treatment of patients with substance addiction syndrome. O'Connor et al. [72] noted a reduction in depressive

symptoms and feelings of loneliness in caregivers caring for dementia patients thanks to the use of avatars in a support group in a virtual environment. Powersa et al. [75] used avatars in psychotherapy for social anxiety and phobia. An experimental study by Pinto et al. [75] focused on the use of avatars in the treatment of patients with depression, and Satter et al. [80] studied avatar therapy in patients with depression and post-traumatic stress disorder.

To sum up, it should be mentioned that computer technology offers great prospects in the development of new or improvement of already known methods of maintaining mental health and self-regulation. As seen in the review, the range of interventions is not limited to mental disorders, for which various psychotherapeutic approaches are actively used. It also concerns the issues of primary and secondary prevention of mental disorders and correction of addictive and behavioral disorders. Furthermore, computer technologies that promote self-regulation of psychological well-being play a special role here [93, 94, 96−99]. However, the study of the extent of their influence requires the application of scientific principles. Due to the relative novelty of the developed methods, it is currently impossible to unequivocally state the degree of their effectiveness, but the available evidence points to the upcoming prospects and importance of such developments in the future. At the same time, this indicates the need for the development of scientific projects and research in this area.

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