Serious games: the future of psychotherapy?
Proposal of an integrative model

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Number of words: 1 012

Number of references: 10

A serious game (SG) is a digital application developed with a "serious" initial purpose that uses the game-playing aspect of video games (VGs). SGs constitute very promising tools in medicine and preliminary results have shown improvements in therapeutic education for chronic disorders, such as diabetes, or for rehabilitation programs [1].

Whereas the literature on mental health effects of VG initially focused on potential negative associations, for example aggressive thoughts and behaviours or depression [2], SGs have recently been proposed as innovative assessment instruments or non-pharmacological treatments for psychiatric disorders. Indeed, these disorders are related to alterations in the cognitive, affective, motivational, and social functions, which constitute relevant targets for SGs. For example, the potential benefit of SGs for adolescents with depression was shown by Merry et al. in a controlled randomized trial [3]. Despite these promising results, questions remain about the place that should be occupied by SGs in psychiatry.

Here, we propose a model in which SGs are integrated into the therapeutic toolbox for psychiatric disorders (see **Figure**). This model is based on the crucial concept of feedback. Three levels of feedback are identified: (i) game feedback, (ii), psychophysiological feedback and (iii) therapist feedback.

Game feedback

The most specific level of feedback regards the gaming interface. Feedback on a game itself is a core feature of SGs.

The choices and actions of the participant have direct consequences in this virtual environment, leading the patient to adapt his or her way of playing. This feedback allows for the reinforcement of select voluntary or involuntary behaviours through a reward/punishment system that is integrated in the game.

We would emphasize the importance of the ludic (i.e. characterized by playful outlook) features of SGs because these aspects can have a positive impact on motivation. Indeed, games are designed to be enjoyable, contrary to psychotherapeutic programs, which are designed to maximize efficiency. The playful aspects of a game may therefore help strengthen the patient's intrinsic motivation and maximize the therapeutic effects through better patient involvement. These "fun" features can be incorporated into software through scoring or quests challenging the player, which constitutes one of the main advantages of SGs over other media. However, the level of challenge and difficulty must be adapted to create and foster motivation (causing neither anxiety nor boredom). User needs and preferences must also be taken into account in user-centered and individualized game designs in order to maximize engagement [4]. Indeed, given the heterogeneity of psychiatric disorders and their pathophysiology, game designs have to be adapted [5]. For example, reward processes must be modified depending on the psychiatric disorder targeted. Different rewards should be implemented in the game (i.e. real-time scoring system, theme changes, prizes) and the therapist should be able to take into account the type and severity of the disorder, the patient preferences and any physiological parameters that may be available.

Psychophysiological feedback

Feedback through psychophysiological information can be provided to the patient during his/her participation. This feedback refers to biofeedback, neurofeedback, or Brain Computer Interface (BCI) integration into SGs. The principle of such interfaces is simple: the subject receives information in real-time about a physiological variable (e.g. heart rate). In the case of neurofeedback or BCI, the physiological variable is neural activity. To date, two approaches have been described for this type of device: "active" and "passive".

In the "active" scenario, the participant intentionally tries to control his/her cognitive activity to change his/her brain activity and control an external electronic device, in this case a SG. The goal is to enhance some voluntary or involuntary behaviour using a reward/punishment system. As such, a

learning period is required. In the context of SGs, positive reinforcement can be achieved through scoring or unveiling clues in a quest. When a targeted neural activity is related to symptoms, these techniques may have therapeutic effects [6].

In contrast, for the "passive" approach, the real-time data streaming is used to optimize the user interface [7]. A passive BCI does not require a learning period, but it does improve the interaction between the subject and the game by adapting the content, structure, theme, and gameplay of a SG according to the variables measured. The ultimate goal is to increase the motivation of the participant and to improve the gaming experience. For example, the degree of difficulty of the game can be based on the electroencephalography (EEG) signal related to the level of attention of the subject [7].

Therapist feedback

The third type of feedback is provided by the therapist. Interestingly, recent meta-analyses identified a close relationship between alliance and the outcomes of individual psychotherapy [8] even for internet-based interventions [9]. SGs should then be considered as complementary tools to enrich the intersubjective relationship and not to substitute for the therapist. Indeed, the therapist could thus help the patient transfer skills and coping strategies acquired in the virtual environment to real life (*i.e.*, the "generalization" principle). The therapist also has a crucial role in reinforcing the motivation of the patient by adjusting the game settings (*e.g.*, levels of difficulty and reinforcing specific coping strategies) in a personalized way.
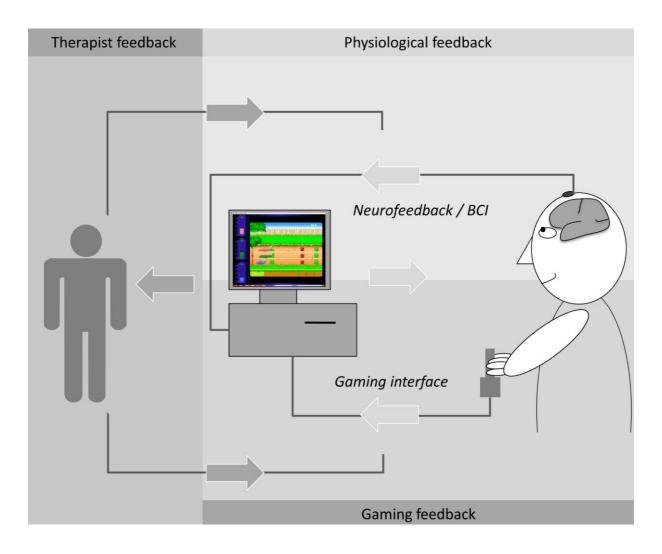
*- Insert Figure "*Serious game in psychotherapy: an integrative model" *here –*

In conclusion, we propose an integrative framework for the use of SGs in psychotherapy, showing how patients could develop alternative coping strategies using this type of device. Promising initial results with SGs in psychiatry have already been obtained for depression, autism and attention deficit/hyperactivity disorder [10] but applications can probably extend to the entire field of mental and behavioural disorders. We recommend the use of the three different levels of feedback described above for the development of future SG software, which will also need validation through controlled randomized trials. A better understanding of how the challenging and ludic features of SGs can be optimized will be crucial in future studies. In complement, analysis of the three previously described levels of feedback could be considered an important research strategy for obtaining better understanding of the motivation and the coping strategies developed through therapy and, notably, the cognitive and neural underpinnings of such. In this regard, the integration of SGs into the psychiatric research framework offers new perspectives for innovative psychotherapy.

FIGURE

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