Gamification in Physical Therapy: More Than Using Games

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The implementation of computer games in physical therapy is motivated by characteristics such as attractiveness, motivation, and engagement, but these do not guarantee the intended therapeutic effect of the interventions. Yet, these characteristics are important variables in physical therapy interventions because they involve reward-related dopaminergic systems in the brain that are known to facilitate learning through long-term potentiation of neural connections. In this perspective we propose a way to apply game design approaches to therapy development by "designing" therapy sessions in such a way as to trigger physical and cognitive behavioral patterns required for treatment and neurological recovery. We also advocate that improving game knowledge among therapists and improving communication between therapists and game designers may lead to a novel avenue in designing applied games with specific therapeutic input, thereby making gamification in therapy a realistic and promising future that may optimize clinical practice. **(Pediatr Phys Ther 2017;29:95–99)** *Key words: gamification, motivation, therapy design, co-creation*

INTRODUCTION

In recent decades, changes have occurred in physical therapy interventions in general, and in pediatric neurorehabilitation in particular. Various effects of pediatric physical therapy interventions have prompted a novel view on their assumptions and principles.[1,2] Shifts have occurred toward task-oriented functional approaches, focusing on practicing activities in a relevant context, as well as changes from hands-on to hands-off approaches.[3-7] As motivation and engagement are crucial aspects of rehabilitation, these novel approaches require therapists to create an attractive and challenging setting that stimulates participants to practice skills.[8]

It is arguable that interactive, engaging game-based rehabilitation tools, which match the abilities of the participant, could provide variation and attractiveness, thereby facilitating recovery of residual motor and cognitive function.[9] We propose to fine-tune physical rehabilitation approaches by combining knowledge from the fields of neuroscience and game design. Gamification is a well-known term in scientific research, and is used in a range of professional areas. The use of game mechanics, also known as tools for creating gamification, is essential and may lead to engagement and motivation in this originally nongame-related field.[10] The use of game design in therapy differs from the use of motor enriching toys in therapy.[11] In interactive game design, a context is created in which the therapist is observing and treating using a virtual environment; the game mechanics must be seen as a toolkit to provide an extra layer for motivation and intensity of the training. Currently, there is a

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gap between the way exercises are being practiced in therapy, and knowledge from both fundamental research on multisensory approaches, and the role of reward systems in games. Moreover, for therapists, adding gamification can have added value in therapy to create an attractive and challenging setting. Therapists can expand their "toolkit" to bring variation and attractiveness in the exercises to prevent monotony.

Novel technology advances, such as interactive virtual reality, mobile computers, and powerful tablets, now provide an opportunity to combine insights from fundamental neuroscience, game design theories, and clinical practice. This perspective critically evaluates the challenges and opportunities to connect neuroscience knowledge, game design thinking, and physical therapy in clinical practice to create an additional toolkit for therapists. The purpose of this perspective is to explain the potential of game design principles to generate more motivation and content for therapy, rather than to encourage readers to create their own digital games.

MULTIPLE WAYS OF USING GAMES AND GAMIFICATION

Virtual reality games can provide attractive therapy settings that create possibilities for the child to engage in artificial scenes (with objects and events) that appear and feel similar to real-world scenes, supporting concentration on, and motivation for therapeutic goals.[12] In view of the current explosion in the use of virtual interactive options, the large range of computer games available and their universal popularity,[13] therapists may consider the opportunities for new strategies and tools that can be applied in therapy.

Game designers have extensive knowledge on eliciting player behavior and motivation that can be useful in therapy settings. Although it is clear that the use of games in therapy can be very motivating, we argue that there is more than that. Game designers do not possess medical or therapeutic knowledge, and in most cases a commercial game cannot be used directly as a therapeutic instrument. By reducing the gap between therapy designers (therapists) and game designers, there is a huge potential to gain more from the potential value of participant-specific games.[14] It is important that both groups learn each other's language and understand and use each other's design models to optimize game development for therapy purposes and to optimize the use of game principles in therapy. In closing the gap between game design and therapy design, therapists may improve the intensity and quality of the therapy. The therapist could consider the use of more game design elements in a therapy session and add therapy design elements in a game set-up.

We propose 3 options of using games and game design in (pediatric) physical therapy:

A. Game principles can be used in therapy to create engagement and motivation, which presumably leads to increased intensity of training. An example is demonstrated below. The process of adding game principles or mechanics is called gamification.
B. Commercial games can be used in therapy with the addition of therapeutical tools to create a therapeutic setting. Exercise tools such as dumbbells, dynabands, or weight belts can be used while playing the game. Alternatively, the child can sit on a cycle machine or treadmill while playing.
C. Applied games, or adjustable exergames, can be used with the therapist selecting exercises linked to the therapeutic needs of the child. The more specific adjustable variables the game contains, the more effective the training. Most exergames lack sufficient adjustable variables to match the range of needs of the child. The therapist can resolve this by adding additional tools/materials (see B), being increasingly successful when the child is motivated to play this exergame. Also, the added data collection provided by playing the game can be helpful in terms of therapeutical feedback, and also for research to develop applied games and learn about players' characteristics while training with the use of games. Therapeutic feedback gained and present by the game or computer is a promising option of creating learning possibilities for the child. The human factors in terms of not being complete can be solved by using extra relevant feedback given by the game of other added technical device.[15]

IMMERSION AND REWARD IN GAME-RELATED "MULTISENSORY THERAPY"

Influenced by the introduction of computers in education and for entertainment purposes, knowledge about the way people learn has increased and more insight has been gained about learning styles.[16] There is no simple answer to the question how children learn, and what learning style they prefer.[17,18] Shaffer et al[19] developed educational methods in which skills are hidden in larger tasks, using computer games. These so-called "immersive games" have been developed as games that include all the context-related, engagement and motivational factors, with skills that have to be learned hidden in the game. An immersive game is defined as a game in which the user feels just as immersed as they would feel in reality.[20] This implies that the task is becoming so real that the emotion it evokes may become similar to emotions in real life.

While playing an immersive game, attentional engagement plays a key role, in capturing focus for the rehabilitation task in the game, as well as in preventing distraction. Behavioral experiments[21-23] have shown that combinations of auditory and visual stimulation can be more powerful to help observers control their attention than unisensory stimulation. More precisely, it has been found that rhythmically *synchronous* cues (ie, visual, auditory, and/or tactile cues that are temporally repetitive, appearing at the same

moment, in the same rhythm) can provide a substantial advantage to control attention over perceptual selection, as much as 400% in some healthy subjects.[21] Because *synchronous multisensory cues* facilitate voluntary attention in healthy observers,[21] they might provide critical support for patients. Synchronous multisensory cues may enable a more rapid and fuller recovery as the patient is supported in learning to control attention.

Beyond the usage of multisensory synchrony in sensory stimulation to capture attention, repetition of stimulation is also important. The brain is a search engine that is continuously looking for correlations between the firing pattern of neurons.[24] Once 2 neurons are repeatedly activated ("fire") together, they will bond and form part of a new neuronal network[25]: "firing together is wiring together."[24] A next level of games for physical therapy could potentially incorporate such insights from neuroscience by repeating specific parts of the game that pertain to specific rehabilitation tasks. For example, making information collection a repeatable, challenging task (thereby triggering specific neurons of interest to fire together) can enhance the player's neurological recovery, and thereby their learning capacity. The player may make the hidden knowledge explicit, by becoming aware of their actions in the therapy tasks.

Rewards facilitate dopamine release, which in turn can facilitate neural plasticity and learning[26,27] through long-term potentiation of synaptic connections.[26,28] Games have been shown to enable the release of dopamine.[29] Using game-evoked rewards, it is possible to manipulate behavior and consequently influence the therapy focus of the child in a positive way. We can also assume that the effect of dopamine can have influence on depression or other negative social emotional clinical presentations. The production of active responses could add in the facilitation of the recovery of residual function as there is direct neuroscientific evidence, initially from animals[30] and later in human,[31] that the brain learns new patterns of interaction with the world faster when active responses are involved.

PARALLELS BETWEEN GAME DESIGN AND THERAPY DESIGN: IMPLICATIONS FOR THE THERAPIST

There are parallels between game design and therapy design, implying potential opportunities for improving engagement and motivation in therapy. We propose that a process of bringing game designers and therapists together can result in more opportunities to optimize therapy.[32] This is described below using a clinical example of a therapy where knowledge of game design becomes a practical asset for the therapist. An interesting question is whether therapists can learn to use game knowledge to achieve engagement, attractiveness, and motivation in their therapy setting. When the therapist is aware of being a designer of behavior, just like the game designer is concerned with the content of the game, the first step in using gamification in therapy has been taken.

The next step in learning about game design is to make the parallels between designing behaviors in therapy and in games specific: the "little game" and the "big game" can be distinguished (Table 1). This is related to option A as stated earlier. Subgoals (little games) are related to main goals (big games) in therapy as well as in game design. The way commercial off-the-shelf (COTS) games, such as Nintendo's Super Mario Bros, are designed provides inspiration for creating higher levels of engagement and motivation in therapy. This "game"-way of looking at therapy design can support the creation of a more playful and context-specific setting, which is necessary for hands-off therapy. Children are likely to be motivated during therapy, which has the potential for greater therapy involvement and higher intensity.

The promising step in the process of developing a therapy with game characteristics is to individualize the therapy by using personal knowledge and medical knowledge of the participant to create an attractive therapy context. Creating an explicit playing field with rules allows children to start gaming without knowing that the therapist has hidden extra information or challenges in the game. Therapists should realize that they can manipulate the game, in "real time," in such a way that the level of training is guaranteed, and the child's behavior is being elicited in the intended physical, cognitive, or social-emotional direction. Using this approach means that the therapeutic input does not differ from that in conventional therapy. The main difference is the outward appearance, where a context- and interest-related game results in increased motivation, attractiveness, and engagement. In every phase of the training program, the therapist has to screen the child's level of performance and analyze whether the level is appropriate for the child in view of his or her current level and therapeutic goals.

Eliciting behavior in therapy in such a way leads to a new type of hands-off design method: gamification of

TABLE 1

Parallels Between Designing Behaviors in an Interactive Computer Game Context and a Clinical Therapy Context

	Games	Therapy
Little game	Separate level where different skills are being trained, subordinate but connected to the skills that need to be finalized in the game (eg, Mario Bros: learning how to jump; learning how to shoot)	Separate therapy skills subordinate to the main therapy goal. This is what is called subskills (eg, taking small steps; standing on 1 leg; doing squats)
Big game	This is the final goal that needs to be attained when all levels have been completed and all skills learned (eg, Mario Bros: defeating the big enemy in the final level by jumping on him and shooting at him)	This is the final goal of the therapy, for which subskills are being practiced (eg, climbing stairs)

therapy. As stated earlier, gamification is defined as the infusion of game mechanics, game design techniques, and/or game style into nongame context, such as therapy.[33] By using these mechanics or techniques, the therapist becomes a game designer while creating a specific therapy. For clinical practice, Table 2 includes an example of a therapist who is concerned with "designing" a therapy in a rehabilitation setting. Integrating game design elements in a therapy has the potential to make the therapy more exciting and attractive, without the use of computer games, only game design knowledge and experience. Note that in game design the primary goal is to create and manipulate behavior.[20] The term *behavior* must be interpreted as any physical, cognitive, or social-emotional response resulting from the therapist's input. To be able to manipulate and create behavior efficiently, it is vital to explore a child's interests and hobbies. From the start of participant contact, this exploration is embedded in the process of history taking, to identify triggers and characteristics in support of game-playing decisions, so that the child will be fully motivated.

In the example in Table 2, it is obvious that the child is engaging in an activity that she likes to do, creating a high level of motivation. The therapy goals are implicitly embedded in the task but not recognized as such by the child. Game designers use the term "suspension of disbelief" to describe the player's mental state in which he or she knows it is just a game, but is willing to "give in" to pretend it is a form of reality.[33] The child's motivation is optimized by means of therapy tools, tailored to the child's interests. This task includes all 6 dimensions of game design described by Garris et al,[34] all individually tailored to the child: (fantasy) the child needs to use their imagination to collect different photos; (rules/aims) there are rules and aims defined by the therapist; (sensory stimuli) the child has to act and react on the basis of their sensory feedback/stimuli by screening their own actions; (challenge) there is a time challenge; (mystery) there is mystery because the child is not sure what they will find in the building; and (control) there is control because the task is clear and the child knows how the camera works. In therapy, these dimensions have also been recognized as important.[35-37] However, these game dimensions are not the only aspects that define the effect of therapy, as the content of the therapy is also important in targeting the therapy goals.

CONCLUSION

In this perspective, the parallels between designing games and designing therapies have been discussed. These parallels have implications for both therapists and game designers, which might lead to optimized therapy, and goes beyond the use of COTS computer games in therapeutic

TABLE 2

Case Example: Gamification of a Therapy Task

Case diagnosis	A 5-y-old girl with traumatic brain injury, with brain damage located in the left hemisphere after traffic accident
Child's interests	1. Pony riding and care 2. Sports 3. Role-play, dress like a princess
Therapy goals	1. To increase coordination, selectivity, and muscle strength of the right hand as needed in single-handed activities 2. To increase balance and stability during the process of multitasking while walking independently and safely 3. To increase memory and attention for daily activities.
Therapy/assignment	"I will first turn you in to a beautiful princess. Then your task is to collect all escaped horses (pieces of a puzzle), while riding on this horse (push bike) and bring them back to your castle tower. You first can have 30 seconds to check all hiding spots. After every single piece you need to climb the castle stairs and lock the horses in the castle tower. While walking the stairs, you hold the pieces in your right hand. You win when you have collected every horse within ten minutes. Then the therapist will sing you a princess song. If not, you have to perform a song while riding your horse."

TABLE 3

Therapist Toolkit for Gamification in Therapy

Use game mechanics: • Fantasy • Rules/aim • Sensory stimuli • Challenge • Mystery • Control Use game language: • Big game and Little game • Therapy levels to achieve	Personalize immersive therapy: • Use the interview to find out personal therapy goals and personal interest • Create an attractive playfield where therapeutic interventions are implicitly hidden in the game or task	Be aware of the neuroplasticity function of rewards: • Dopamine facilitates synaptic connections in the brain • Synaptic connections will support the (motor) learning effect in the brain

- Altogether, this can create immersive therapy and can lead to longer maintaining focus and attention of therapeutic interventions
- This can create "flow," a mental state of operation in which a person performing an activity is fully immersed in a feeling of energized focus, full involvement, and enjoyment in the process of the activity
- Flow can create a release of extra dopamine, which can result in a "feel good" state
- When succeeding a game/therapy level, an "O yes" feeling can result in extra dopamine release

settings. Therapists may consider studying gaming principles and insights. The content for creating an optimal individualized context for therapy is presented in Table 3. This goes beyond the use of computer games to a mindset of using game elements for therapy. The gamification of therapy has potential to increase participants' motivation and engagement in therapy. Engagement and attentional focus is important in physical therapy interventions because it involves reward-related dopaminergic systems in the brain that improves synaptic connections and are known to facilitate learning through long-term potentiation. The use of therapeutic principles in game design could result in more therapeutic applied computer games[38] in which the therapist can influence the levels on an individual basis, to boost motivation and efficiency.

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