Use of digital console game for children with attention deficit hyperactivity disorder*

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Abstract: ADHD or ADD (Attention Deficit/Hyperactivity Disorder) is one of the most frequently diagnosed mental and behavioral disorders of children. Children with ADHD are characterized by poor attention and distractibility and/or hyperactive and impulsive behaviors. Although there is no "cure" for ADHD, there are accepted treatments that specifically target its symptoms. The most common standard treatments include medication, psychological or behavioral modification, and educational approaches. However, more and more parents began to worry about the side effects of medication. For this reason, this study proposed a new treatment by using digital console games to assist children who suffer from ADD to improve their attention condition. With the advantages of gaming apparatus, this study intends to improve the effect of behavioral intervention and cognitive remediation therapy for ADD children.

Key words: digital game; ADHD; game-based learning; attention

1. Introduction

According to "DSM-IV-TR" (The Diagnostic and Statistical Manual of Mental Disorders, 4th edition text revision), ADHD (Attention Deficit/Hyperactivity Disorder) is the most common psychiatric disorder that can be identified generally during children's growth progress (American Psychiatric Association, 2000). The incidence of ADHD continues to rise and is a significant challenge on medical, financial and educational resources (Birnbaum, Kessler, Lowe, Secnik, Greenberg, Leong & Swensen, 2005). In order to gain more understanding about ADHD, there are 3 main symptoms that have been discovered to further the research as well as current study. They are inattention, hyperactivity and impulsivity. The primary symptoms of inattention are that, either children fail to give close attention easily or they have difficulty sustaining their attention. Moreover, children with ADHD usually also have problems in inside behavior: cognition, emotion, learning, behavior and deficit of relationship (Wicks-Nelson & Israel, 2000).

In order to help ADHD patients, researchers in medical profession, psychology and education are devoted to find the cure. So far, there are a variety of approaches for ADHD. Currently, a variety approaches and treatments

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have been used to cure ADHD, including medications, appropriate educational program, behavior therapy, cognitive behavior therapy, psychotherapy, sensory integration therapy and parent education. On the basis of upon treatments, researchers believe that medication is the most important part among others for those children who have ADHD. However, more and more parents are concerned and worried about the side effects of medication for the methylphenidate. They also regard ADHD as psychological problems rather than physiological problems. Furthermore, research results indicate that, medication only can improve ADHD symptoms temporarily. For better inside control and well-behavior, behavior therapy and cognitive behavior therapy are integral parts of treatment for ADHD patients. Working together with education and parent counseling can enhance and encourage positive behaviors of ADHD children. However, there is a disadvantage of behavior therapy. The most important techniques for behavioral intervention strategies are consistency and positive reinforcement, which require lots of time and efforts from parents and teachers in order to adjust ADHD children's behavior in time (Children and Adults with Attention-Deficit/Hyperactivity Disorder, 2009).

Therefore, the purpose of this study is to propose a more effective approach than traditional behavior therapy for ADHD children. This approach need to lessen parents' concern of medications and reduce caregivers' times for the ADHD children. In this study, researchers investigated the possibility of using digital console games as the behavioral intervention strategy to improve the training motivation efficiency of ADHD children and their attention sustention.

2. Literature review

To build up the connection of ADHD, attention and digital games, the researchers reviewed related literature for this study.

2.1 ADHD

As mentioned above, ADHD is one of the most pervasive childhood neurobiological disorders and it may persistent interfere with the adolescence and adulthood (Children and Adults with Attention-Deficit/Hyperactivity Disorder, 2009). Symptoms include difficulty sitting still, paying attention, controlling impulsive behavior or even hyperactivity. ADHD has 3 subtypes: predominantly hyperactive-impulsive, predominantly inattentive, and combined hyperactive-impulsive and inattentive. ADHD is a complex disorder that often requires input from the affected children or adolescents, teachers, parents and physicians in order to be diagnosed correctly and treated successfully (McGough & McCracken, 2000).

There are 3 main approaches for ADHD: (1) medications; (2) behavior therapy; and (3) CBT (cognitive behavior therapy). Recent studies indicate that synthetic treatments have better effect for ADHD patients (Barkley, 1998). The detail explanation of these 3 approaches is described as following:

(1) Medications

The methylphenidate widely used is "Ritalin" and "Concerta". The comparison of these 2 types of drugs is shown in Table 1 (Lopez, Silva, Pestreich & Muniz, 2003). The clinical experiences show that, 80% of the ADHD children had significant improvement in symptoms after following the medication treatment, but there are short-term and long-term side effects of this approach.

(2) Behavior therapy

Behavior therapy is to promote positive behaviors and eliminate bad behaviors by reward and punishment. Barkley (1998) pointed out that, the approach of behavioral intervention strategies is an effective counseling to

ADHD children. Three effective techniques to ADHD children are: (1) providing treatment immediately to behavior; (2) high frequencies; and (3) significant. Behavior treatment for ADHD also uses the purposeful activity to improve the symptoms and makes children conduct themselves in the activities.

Table 1 Comparison of Ritalin and Concerta

	Ritalin	Concerta
Element	MPH (Methylphenidate)	
Effect	Both of 2 stimulate secretions of brain to improve ADHD	
Times	short-term (about 4 hours)	long-term (about 12 hours)
Side-effect	Side-effect is significant (e.g., headache, palpitations and vomit)	The effect is moderate, and the frequency side-effect is lower
Conveniences	Taking many times one day, it almost had to take out	Taking one a day, it is convenient to the children with forgetful

Source: http://www.uho.com.tw/sick.asp?aid=4500.

(3) CBT

CBT aims to influence dysfunctional emotions, behaviors and cognitions through a goal-oriented, systematic procedure. It is the main treatment except medications. The usual method in this therapy is self-control, which emphasizes that one person control behavior through talking to oneself (Conte, 1991). Meichenbaum (1977) combined main concept of cognition and behavior to develop self-instructional strategy. These first 2 conceptual stages were heuristically useful, as they yielded the development of self-instructional training, stressing inoculation training and various cognitive restructuring procedures. He divided self-instructional strategy into 5 steps: (1) cognitive modeling; (2) overt external guidance; (3) overt self-guidance; (4) covert self-instruction; and (5) faded self-guidance (Meichenbaum, 1986).

Goal-oriented and high frequencies approach forms a main idea of this study. By playing games, it enhances impress in consciousness of ADHD children gradually and assists the self-conduct in games to achieve purposes of attention improvement and self-control. The use of the attraction to children becomes rewards and punishments in behavior control. Based on the above literature, the study brings forth to improving in ADHD children.

2.2 Attention

There is no standard definition for attention, and different scholars have various interpretations. Basically, attention means reacting to what must stimulus reaction, and not responding to what must not stimulus it. Lewis, Loveland, Pearson and Yaffee (1996) considered attention as finite general cognitive processing resource. James (1890) thought that attention includes focalization and concentration. Focalization could be treated as selective attention, and concentration could be sustained attention. In a word, attention is putting consciousness on important message, then to stimulate and achieve the efficient allocation of mental resources through selection and sustainment. For this reason, attention is very important for effective learning.

On the other hand, inattention is a significant characteristic of children who have ADHD. And, it is one of the main reasons why these children easily have learning disability. To understand the characteristics of attention in ADHD will help parents and teachers choose appropriate strategies in order to improve attention. For the needs of ADHD children, a recently published study evaluates the effectiveness of one such attention training tool called “Pay attention!”. The tool is based on the attention theory of Sohlberg and Mateer (1987), including 4 dimensions: selective attention, sustained attention, alternating attention and divided attention. The content of this tool are full of bright colors and pictures. Through the systematical training activity, it can stimulate children’s attention of

visual and auditory. The results indicate that, the participants' attention was improved significantly (Kerns, Eso & Thomson, 1999).

From prior researches, this study believes that appropriate activities can stimulate ADHD children's attention of visual and auditory. The stimulation and training of multimedia objects enable to improve the selective attention of ADHD and require to finish training the ability of receiving instructions correctly. These findings give this study a powerful foundation that, reward and self-challenge can create internal force to improve children's sustained attention with the challenges of mission and times of playing.

2.3 Digital games

Digital games bring a new perspective in the content of games: It makes players immerse in the other world (DeMaria & Wilson, 2004). In the game world, the players contact images (or objects) through visualization, and then, become a series of spurs shock and reaction that get up to use attention. It supplements the lack of non-digital games and stimulates sound and image. Recently, there are many studies indicating that digital games have positive effects on training and could be applied as a teaching tool. Prensky (2007) stated about the relations of games, fun, enjoyment, motivation and learning. They believed that, learners can learn in fun, improve motivation of learning, take easy to learn and enjoy the learning. Chuang and Chen (2009) also investigated the effects of digital games playing on the subject of cognition of elementary-level students. The results from this study, which provided experimental evidence to support the use of digital games, can facilitate students' cognitive learning process. Watters, et al. (2006) proposed the architecture in applying games to health-care that games are targeted for increasing the motivation of patients in 3 areas: (1) to increase a patient's motivation to engage in learning the ins and outs of their condition and its treatment; (2) to use games as a tool in distraction therapy for pain and anxiety; and (3) to encourage young patients to continue with their treatments over longer treatment regimes. Additionally, an increase in motivation is directly related to children's attention and concentration (McFarlane, Sparrowhawk & Heald, 2002). The findings of Rosas and his colleagues' research (2003) reported that students who use educational games spend more of their potential learning time being concentrated, and that this is more evident in students with attention problems and low achievement, because digital games can provide the course of interaction and rise of mental power. Using digital games appropriately, it raises external motivation or internal power to further purpose and the concept, enhances stimulation and is used in behavior therapy in ADHD.

Due to the difference of devices, game console could divide into arcade game, video games, handheld game, VR (virtual reality) and PC game. In 2006, Nintendo released a home-video game console called "Wii". It has the novel game console, and its motion-sensor can directly respond the action of player, so the device provides the different experience of games. Wii has pioneering-operation functions and plays with greatly interactive mode. The game uses the motion sensor capabilities of the Wii Remote and Nunchuk attachment to control the actions of the on-screen character. Using the controller provides a natural, intuitive and realistic feeling. The intuitive mode is able to greatly decrease the sense of frustration when ADHD children learn how to operate.

Digital games provide entertainment, and also apply to education and medical science widely. Deutsch, Borbely, Filler, Huhn and Guarrera-Bowlby (2008) investigated a 13-year-old adolescent with spastic diplegic cerebral palsy that plays Wii sports at 11 training sessions in 2-3 weeks, and these sessions were 60-90 minutes in duration. The outcome indicates that, the activity can increase the attention and motivate. In playing Wii, operator can interact with virtual object through moving and pointing. The operation mode not only conforms to the demand of treatment in ADHD, but also improves cognition problem: visual-motor coordination and problem-solving.

After a preliminary analysis of the interactive performance and the digital games of Wii, this study considers this new technology can be a powerful and useful learning tool to assist the behavior therapy for ADHD. Through the appropriate design of training strategy, this study believes that this device can provide multi-sensory stimulus to improve the deficit of selective attention and sustained attention in ADD children.

3. Experiment

To find out the possibility of applying digital game in ADHD children's attentions improvement, this study combines principle of activity design with concept of game theory in behavior therapy and cognitive behavior therapy. This study develops a treatment with digital games that improve selective and sustained attentions.

Participants have to be divided into control group and experimental group. Participants have treated in hospital in Tainan, Taiwan. Control group participants are usual with cognitive behavior therapy twice a week; experimental group participants are in treatment of video games and cognitive behavior therapy.

There are 9 games in "Wii play", the authors choose "shooting range", "find Mii", "table tennis", "laser hockey" and "charge!"; There are 5 games in "Wii sport", the authors choose "tennis", "baseball" and "boxing" (see Table 2).

Table 2 "Wii play" and "Wii sport"

	Name	Introduction	Objective
Wii play	Shooting range	Players go through various rounds of shooting balloons, targets, flying discs, cans and UFOs	Selective attention, sustained attention, visual-motor coordination and problem-solving
	Find Mii	Crowds of Mii characters will gather on the screen, standing, swimming, walking and doing other things, and the player is given certain details to look for among them. The player then must pick out the Mii that match the objective	Selective attention, sustained attention and visual-motor coordination
	Table tennis	This game is, essentially, a game of table tennis, rallying back and forth by moving the Wii remote	Sustained attention and visual-motor coordination
	Laser hockey	Played like air hockey, this is a 2-player game where the players move the Wii remote to deflect shots and try to score in the opponent's goal	Selective attention, sustained attention and visual-motor coordination
	Charge!	The player rides a cow and topples scarecrows to accrue points	Selective attention, sustained attention, visual-motor coordination and problem-solving
Wii sport	Tennis	Everything in this game can be controlled using actions with the Wii remote. Running around the court is controlled automatically so the player only needs to worry about hitting the ball	Sustained attention and visual-motor coordination
	Baseball	When your team is at the plate, the controller is your bat. When your team is in the field, the controller is the pitcher's arm, and the buttons determine what type of pitch to try to throw	Selective attention, sustained attention, visual-motor coordination and problem-solving
	Boxing	This game is the only game on Wii sports to use the Nunchuk attachment. To control your player you basically need to imagine that the controllers are your fists	Selective attention, sustained attention and visual-motor coordination

Using "Find Mii" as an example for the design principle of this study: This game conforms the cognitive behavior therapy theory (see Figure 1). In "find Mii", ADHD children can find out the objects that represent themselves in game, and form self-image models. The impression form self-restrictions to their behaviors when back to the real world. This study also intends to train ADHD children's attention sustention during game playing.

Figure 1 Find Mii screenshot

According to the content and demand of study, this study will collect 8 participants that have diagnosed inattentive or combined inattentive with hyperactive by doctor or therapist. Before this experiment, participants need complete pre-test data collection and begin a 3-month research. IVA+Plus CPT (Integrated Visual & Auditory Continuous Performance Test-Plus, n.d.)[1] is a unique combined auditory and visual continuous performance test designed to help the clinician make an accurate diagnosis of ADHD (see Figures 2 and 3), which will apply in this study as pre-test and post-test. When the experiment initiates, participants must terminate all other treatments except cognitive behavior therapy and the activity of research. During the experiment, the researchers will record the whole playing process with monitor-recording software in audio and video media. When the experiment finishes, participants need to complete the post-test data collection in order to compare to the pre-test results. The whole data from recording and tests will use process independent-sample t-test and chi-square test to evaluate the difference.

Figure 2 IVA+Plus CPT

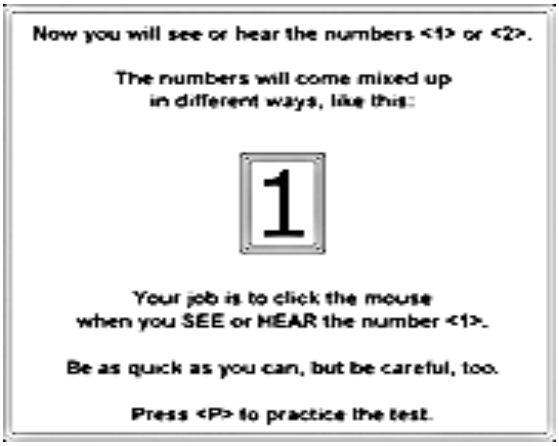

Figure 3 IVA+Plus CPT screenshot

4. Conclusion

Recent research found that, Nintendo Wii Fit and Wii Balance Board could be used to stimulate children who suffer from sensory integration dysfunction to rebuild the relationship between their behaviors and brain functioning (Chuang, Lee & Lin, 2009). With the advantages of this new game system, therapist can motivate children into the training plan to improve the effects of their sensory integration therapy. For this reason, researchers apply digital console games as an assistant tool for ADHD treatment in this study. It makes ADHD

[1] IVA+Plus. (n.d.). Retrieved January 11, 2010, from http://www.braintrain.com/professionals/adhdtesting/ivaplus_pro.htm.

children get more fun when they are in training. It is hoped to improve ADHD children's attention effectively while playing digital games. It provides an innovative approach to ADHD therapy. The authors intend to extend digital games from entertainment domain to education, and even bring it into medical treatment domain, such as ADHD children's attention improvement. This study creates a different viewpoint for further research.

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