



CASE REPORT

REVISED Case Report: "ADHD Trainer": the mobile application that enhances cognitive skills in ADHD patients [version 3; referees: 1 approved, 1 approved with reservations]

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Abstract

We report the case of a 10 year old patient diagnosed with attention deficit hyperactivity disorder (ADHD) and comorbid video game addiction, who was treated with medication combined with a novel cognitive training method based on video games called TCT method. A great risk of developing video game or internet addiction has been reported in children, especially in children with ADHD. Despite this risk, we hypothesize that the good use of these new technologies might be useful to develop new methods of cognitive training. The cognitive areas in which a greater improvement was observed through the use of video games were visuospatial working memory and fine motor skills. TCT method is a cognitive training method that enhances cognitive skills such as attention, working memory, processing speed, calculation ability, reasoning, and visuospatial coordination. The purpose of reviewing this case is to highlight that regular cognitive computerized training in ADHD patients may improve some of their cognitive symptoms and might be helpful for treating video game addiction.

Open Peer Review

Referee Status:

	Invited Referees		
	1	2	3
REVISED version 5 published 26 Oct 2015			 report
REVISED version 4 published 10 Sep 2015		 report	↑
REVISED version 3 published 23 Jun 2015		 report	↑
REVISED version 2 published 07 May 2015	 report	 report	↑
version 1 published 18 Nov 2014	 report		

- 1 Aviv Weinstein**, Ariel University Israel
- 2 Kevin J. Black**, Washington University in St. Louis USA
- 3 Gabriele Duccio Papanti**, University of Trieste Italy

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[Comments \(2\)](#)

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Grant information: The author(s) declared that no grants were involved in supporting this work.

Competing interests: Dr. Kazuhiro Tajima-Pozo, participated in the development of "ADHD Trainer", and other mental health applications at TKT Brain Solutions, which is a Spanish startup, made up of physicians and engineers, whose aim is to develop mental health applications.

First published: 18 Nov 2014, **3**:283 (doi: [10.12688/f1000research.5689.1](https://doi.org/10.12688/f1000research.5689.1))

REVISED Amendments from Version 2

- We have modified some of the statements in our conclusions.
- We have included a table showing the cognitive training areas that are trained with the app.
- We have made an overall review of the grammar.
- We have included the scores of the school situations questionnaire.

See referee reports

Introduction

Attention deficit hyperactivity disorder (ADHD) is the most commonly diagnosed neurodevelopmental disorder in childhood, which affects 3% to 7% of the population worldwide¹. ADHD is characterized by distractibility, hyperactivity and impulsivity. The standard treatment for ADHD includes mainly medication, psychosocial and behavioral treatment, and cognitive training exercises.

Cognitive training exercises are especially useful when cognitive impairment is observed and when a regular and personalized cognitive training is performed². Studies in participants with cognitive impairment have shown that regular and daily cognitive training can improve some of their cognitive symptoms^{3,4}. In addition, recent studies have demonstrated that computerized working memory and executive function training programs lead to better results than ordinary cognitive training methods in children with ADHD⁵⁻⁷.

Children's use of electronic devices, Internet and video games, has noticeably increased in the last 10 years. Since the first case of Internet addiction was described in 1996 by Young⁶, several other pathologies have been proposed including pathological gambling and dependence⁷. Despite extensive research literature available, the prevalence and proper diagnostic criteria for pathological gaming are still debated among the scientific community⁸. Gaming addiction represents part of the postulated construct of Internet addiction, and is the most widely studied specific form of Internet addiction to date⁹. Prevalence estimates range from 2%¹⁰ to 15%¹¹, depending on the respective socio-cultural context, sample, and assessment criteria utilized. A great risk of developing video game or Internet addiction has been reported in children, and especially in those with ADHD⁸. Stimulants such as methylphenidate (MPH), given to treat ADHD, and video game play have been found reduce Internet use in subjects with co-occurring ADHD and Internet video game addictions⁹.

Despite the risk of Internet addiction we hypothesize that good use of these new technologies can be useful to develop new methods of cognitive training useful in to treat ADHD an Internet addiction.

Case report

This case study involves a 10 year old child born in Madrid (Spain) who received treatment in a childhood psychiatry unit for 2 years due to behavioral disorders and ADHD. No other previous medical history was reported. His mother, aged 35, received psychological treatment for anxiety 3 years ago. His father, aged 36, works as

an engineer and presented no relevant medical history. The patient was their only son. The parents described a great addiction to video games in the last year, referring 4 hours per day of video game playing, affecting his social interaction, and causing a lack of imaginative play and poor academic scores. Teachers at the school reported deterioration in his academic performance over the past year. At that time, the child was treated with methylphenidate 40 mg per day. The patient's parents reported to the psychiatrist that the only significant change from the previous year was a major addiction to a war videogame.

To reduce the exposure to video games, we used a novel technique, based on the Tajima Cognitive Method (TCT) called "ADHD Trainer". It consists in a cognitive stimulation program with a mobile/tablet application designed specifically to treat ADHD.

Behavioral and academic improvements were rated on the Conners Parent and Teacher Rating Scales (brief version) and Barkley School Situations Questionnaire.

ADHD diagnosis was made according to DSM V criteria^{10,11}. Attention was rated with CPT Conners Conners Continuous Performance Test.

Differential diagnosis between oppositional defiant disorder and ADHD disorder was considered, because most of the symptoms were observed at home, however not angry or irritable mood was observed.

The patient was treated with a combination of methylphenidate and cognitive training method based in the TCT method. The patient received daily treatment with 40 mg of methylphenidate, and at least 10 minutes of daily cognitive training with the "ADHD Trainer" app.

The TCT is a type of computer adaptive test (CAT), as it adapts to the individual's cognitive strengths and weaknesses, based on his own scores over time, as well as those of his peers. Users receive separate scores in different cognitive areas, including simple calculation, attention, perceptual reasoning, and visuomotor coordination (Figure 1). The goal of the daily training is to reach a pre-set individualized score in different cognitive domains, in order to complete a week of successful training. The exercises comprising "ADHD Trainer" are described in the following Table 1.

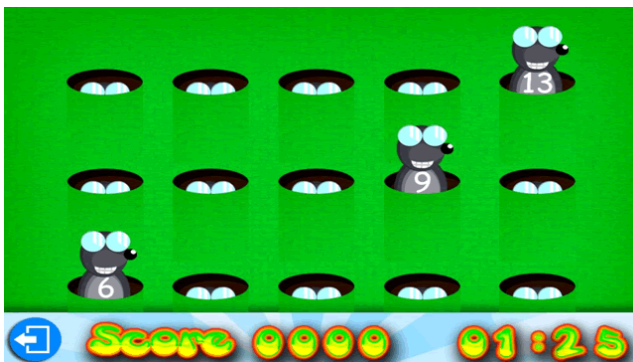


Figure 1. The cognitive areas treated with ADHD Trainer.

Table 1. Exercises comprising “ADHD Trainer from Monday to Sunday, 10 minutes per day.

Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
Attention	Calculation	Attention	Calculation	Attention	Calculation	Attention
Memory	Visuo motor coordination	Memory	Visuo motor coordination	Memory	Visuo motor coordination	Memory
	Perceptual reasoning		Perceptual reasoning		Perceptual reasoning	

During the first month of cognitive training therapy, the patient was only allowed to play with specific games based on the TCT Method, using the “ADHD Trainer” (Figure 2). The patient had to use the app every day at the same time, provided the other targets that were assigned in therapy, such as the progressive reduction in the number of hours to play other games and just being able to play with them once a week, were met. During the first month, he was allowed to play this game to a maximum range of 4 hours per day. No addiction symptoms to this videogame was observed during the first month (tolerance, withdrawal or functional impairment). The average number of hours that the child played the video game was 1 hour a day. In the following months the objective was to play the game at least 10 minutes per day.

**Figure 2.** Capture of one of the games based in Trail Making Test.

In less than two months the video games abuse was substantially reduced, limiting their use to weekends, and always for periods not exceeding 4 hours in total. Although 4 hours a day might be an important amount of time for a single day, the global reduction of the time wasted in videogames and its limitation to the weekend means a significant improvement in this particular case.

Behavioral and academic improvement was rated on the Conners Parent and Teacher Rating Scales and Barkley School Situations Questionnaire. The initial score of the Conners was 19 for the teachers and 20 for the parents, and after the cognitive training the scores were 15 for the teachers and 16 for the parents. The main

severity score for the Barkley School Situations Questionnaire was 70 before starting the training, and after the cognitive training the score was 66.

Both the school and the family reported a significant improvement in the patient after 6 months of TCT cognitive training, which included important improvements of both academic and behavioral outcomes.

Discussion

Most of the studies reported so far emphasize the potential addictive risk of new technologies and the influence they have on children’s interpersonal development, by reducing the time children spend outside home and increasing the time they spend alone playing in front of a television or a computer screen¹². It is also known that the new technologies may affect children’s academic performance by reducing the number of hours that they dedicate to studying.

There are few studies which focus on the positive aspects of new technologies and the opportunities that they offer new ways of interaction between professionals and users as well as the development of new therapeutic methods, capable of reaching the young.

New technologies, in particular video games, can be used as therapeutic tools to train executive functions^{6,7}. As they generate greater motivation in children and adolescents they will increase the frequency of performing cognitive tasks oriented to enhance executive functions, especially the working memory. Previous computerized methods have been purposed and have shown to be better than traditional ones^{13,14}.

There are key advantages for children practicing the TCT Method relative to traditional cognitive training therapies which include:

- 1) Increased motivation in children for completing cognitive training therapy. This increase in motivation comes from: entertainment value (these games are designed to be similar to regular video games that children enjoy) and feedback on performances relative to own and peer scores (which improves children’s sense of agency and self-efficacy, as demonstrated by documented research on motivation and learning)^{12,15}.
- 2) Ease of accessing the application. Children can play the games at any place or time, day and night.

Conclusion

ADHD patients are especially vulnerable to develop video gaming addiction. ADHD patients often suffer from working memory and executive function dysfunctions, but we have observed that very few cognitive training techniques have been developed for ADHD patients in the last years. Poor completion rates of cognitive training in children with ADHD have been observed. We suggest that a daily cognitive computerized training in ADHD patients may improve some of their cognitive symptoms, and might be helpful for treating the video gaming addiction.

Consent

Written informed consent to publish this report was obtained by the patient's parents.

Dr. Tajima takes responsibility for the integrity of the data and informed consent.

Author contributions

Dr. Gonzalo Ruiz wrote the manuscript, supervised by Dr. Kazuhiro Tajima-Pozo and Dr. Francisco Montañes-Rada. All authors agreed to the final content of the manuscript.

Competing interests

Dr. Kazuhiro Tajima-Pozo, participated in the development of "ADHD Trainer", and other mental health applications at TKT Brain Solutions, which is a Spanish startup, made up of physicians and engineers, whose aim is to develop mental health applications.

Grant information

The author(s) declared that no grants were involved in supporting this work.

Acknowledgements

The patient and his family were invited to participate in this study.

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Open Peer Review

Current Referee Status:



Version 3

Referee Report 26 June 2015

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Kevin J. Black

Department of Psychiatry, Washington University in St. Louis, St Louis, MO, USA

The authors have addressed points #1 and 4 from my previous review, but the following issues remain.

2. The paper still needs copy editing to reflect standard written English. The last 2 sentences of the Introduction provide an example.

- Comma placement: Do the authors mean that video game play reduces Internet use, or do they mean that MPH is given for both ADHD and video game play?
- "found reduce" -> "found to reduce"
- Here is one potential way to edit the last sentence (insertions marked with bold; deletions marked with underline and subscript). "Despite the risk of Internet addiction, we hypothesize that good use to of these new technologies can be useful as new methods of cognitive training useful in to develop treat ADHD and Internet addiction."

3a. The exercises comprising "ADHD Trainer" are not described in any detail beyond listing the categories of mental functioning that each task is thought to reflect. For instance, what task is used for "Attention"? Has this implementation of the task been validated elsewhere, or adapted with unpublished modifications from a published task? And so on for each of the categories listed in the Table.

3b. As with any method, the authors need to provide some kind of information about where the reader can obtain "ADHD Trainer".

I have one additional comment that I forgot to add to the previous review.

5. The authors should acknowledge, perhaps in Conclusion, that behavioral interventions other than ADHD Trainer itself may account in part or in whole for the clinical improvement. Other interventions the child received include the following. "The patient was only allowed to play with" ADHD Trainer. "The patient had to use the app every day at the same time." The patient had to meet "the other targets that were assigned in therapy" including a "progressive reduction in the number of hours to play other games" and limiting other game play to once a week.

I have read this submission. I believe that I have an appropriate level of expertise to confirm that it is of an acceptable scientific standard, however I have significant reservations, as outlined above.

Competing Interests: No competing interests were disclosed.

Version 2

Referee Report 15 June 2015

doi:10.5256/f1000research.6850.r8915



Kevin J. Black

Department of Psychiatry, Washington University in St. Louis, St Louis, MO, USA

This is an interesting and encouraging report, but I have the following reservations.

1. One case provides very limited evidence for efficacy and even less for safety. In this light, a couple of statements, including the following, are too enthusiastic and need to be toned down:

"regular cognitive computerized training in ADHD patients can improve some of their cognitive symptoms and can help treating video game addiction"

"We conclude that a daily cognitive computerized training in ADHD patients can improve some of their cognitive symptoms, and can help treating the video gaming addiction."

2. The manuscript is understandable, but needs copy editing by a native English speaker. For instance, the first sentence of the abstract has 2 errors, and the following phrase is really hard to parse: "the method of Tajima Cognitive Method (TCT) cognitive training called 'ADHD Trainer'."
3. The exercises comprising "ADHD Trainer" are not described in any detail beyond listing the categories of mental functioning that tasks were thought to reflect. If another publication or thesis describes it, a reference would suffice; otherwise a list of tasks would be a first step. Similarly, as with any method, the authors need to provide some kind of information about where the reader can obtain the TCT.
4. The Barkley School Situations Questionnaire was administered, but the scores are not reported.

I have read this submission. I believe that I have an appropriate level of expertise to confirm that it is of an acceptable scientific standard, however I have significant reservations, as outlined above.

Competing Interests: No competing interests were disclosed.

Author Response 18 Jun 2015

Kazuhiro Tajima-Pozo, Hospital Fundacion Alcorcon, Spain

According to the reviewer comments
We have included a table showing the cognitive training areas that are trained everyday.
We have made a overall review of the grammar.
We have included the scores of the school situations questionnaire.
Thanks for your review Mr. Black, and best regards.

Competing Interests: No competing interests were disclosed.

Referee Report 18 May 2015

doi:10.5256/f1000research.6850.r8583



Aviv Weinstein

Department of Behavioural Sciences, Ariel University, Ariel, Israel

The authors have revised the manuscript to my full satisfaction

I have read this submission. I believe that I have an appropriate level of expertise to confirm that it is of an acceptable scientific standard.

Competing Interests: No competing interests were disclosed.

Author Response 18 May 2015

Kazuhiro Tajima-Pozo, Hospital Fundacion Alcorcon, Spain

Thanks for your comments and your review. Best regards.

Competing Interests: Dr. Kazuhiro Tajima-Pozo, have participated in the development of "ADHD Trainer" , and other brain training applications as consultant psychiatrist.

Version 1

Referee Report 25 November 2014

doi:10.5256/f1000research.6082.r6739



Aviv Weinstein

Department of Behavioural Sciences, Ariel University, Ariel, Israel

This is an interesting case report on the usefulness of cognitive computer training for a child who is diagnosed with ADHD and concurrent videogame addiction. The rationale for the study, methods and findings are fine but I would like to make some additional comments.

First, the usefulness of treatment of ADHD and internet addiction by using methylphenidate was reported by [Han D et al., 2009](#), please add it to the introduction.

Second, what evidence have you got that the child is not addicted to the educational game?

Third, 4 hours of play of a videogame post-treatment is still a lot, this should be mentioned as a limitation.

Fourth, why were the Conners ratings after treatment for parents and teachers lower compared with pre-treatment?

Fifth, the authors should be commended for the use of advanced computer games for treatment for ADHD. There are other tools for this purpose that are worthwhile mentioning such as ONTRAC (Mishra *et al.*, 2013) and the game reported by Prins PJ *et al.*, 2011.

I have read this submission. I believe that I have an appropriate level of expertise to confirm that it is of an acceptable scientific standard, however I have significant reservations, as outlined above.

Competing Interests: No competing interests were disclosed.

Author Response 10 Dec 2014

Kazuhiro Tajima-Pozo, Hospital Fundacion Alcorcon, Spain

We have included the following new references and made the changes according to the reviewer comments.

Mishra J, Merzenich MM, Sagar R. Accessible online neuroplasticity-targeted training for children with ADHD. *Child Adolesc Psychiatry Ment Health*. 2013 Nov 14;7(1):38

Prins PJ, Dosis S, Ponsioen A, ten Brink E, van der Oord S. Does computerized working memory training with game elements enhance motivation and training efficacy in children with ADHD? *Cyberpsychol Behav Soc Netw*. 2011 Mar;14(3):115-22.

Han DH1, Lee YS, Na C, Ahn JY, Chung US, Daniels MA, Haws CA, Renshaw PF. The effect of methylphenidate on Internet video game play in children with attention-deficit/hyperactivity disorder.

Competing Interests: No competing interests were disclosed.

Author Response 13 Apr 2015

Kazuhiro Tajima-Pozo, Hospital Fundacion Alcorcon, Spain

We have included the following new references and made the changes according to the reviewer comments.

Mishra J, Merzenich MM, Sagar R. Accessible online neuroplasticity-targeted training for children with ADHD. *Child Adolesc Psychiatry Ment Health*. 2013 Nov 14;7(1):38

Prins PJ, Dosis S, Ponsioen A, ten Brink E, van der Oord S. Does computerized working memory training with game elements enhance motivation and training efficacy in children with ADHD?

Cyberpsychol Behav Soc Netw. 2011 Mar;14(3):115-22.

Han DH1, Lee YS, Na C, Ahn JY, Chung US, Daniels MA, Haws CA, Renshaw PF.
The effect of methylphenidate on Internet video game play in children with
attention-deficit/hyperactivity disorder.

Competing Interests: Dr. Kazuhiro Tajima-Pozo, participated in the development of “ADHD Trainer”, and other mental health applications at TKT Brain Solutions, which is a Spanish startup, integrated by medical doctors and engineers, whose aim is to develop mental health applications.

Discuss this Article

Version 1

Author Response 13 Apr 2015

Kazuhiro Tajima-Pozo, Hospital Fundacion Alcorcon, Spain

Thanks for your comments Mr Black! best regards

Competing Interests: No competing interests were disclosed.

Reader Comment (*F1000Research Advisory Board Member*) 20 Nov 2014

Kevin J Black, Department of Psychiatry, Washington University in St Louis, USA

This is a trivial comment, just FYI, but the phrase "integrated by medical doctors and engineers" in the Competing Interests section sounds great in Spanish, but would be better rendered in English as "made up of physicians and engineers."

Competing Interests: none
