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The effect of family therapy on the changes in the severity of on-line game play and brain activity in adolescents with on-line game addiction

Doug Hyun Han [a], Sun Mi Kim [a], Young Sik Lee [a], Perry F. Renshaw [b,*]

[a] Department of Psychiatry, Chung Ang University, College of Medicine, Seoul, Republic of Korea
[b] Brain Institute, University of Utah, Salt Lake City, UT, United States

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ABSTRACT

We evaluated whether a brief 3-week family therapy intervention would change patterns of brain activation in response to affection and gaming cues in adolescents from dysfunctional families who met criteria for on-line game addiction. Fifteen adolescents with on-line game addiction and fifteen adolescents without problematic on-line game play and an intact family structure were recruited. Over 3 weeks, families were asked to carry out homework assignments focused on increasing family cohesion for more than 1 hour/day and 4 days/week. Before therapy, adolescents with on-line game addiction demonstrated decreased activity as measured by functional magnetic resonance imaging (fMRI) within the caudate, middle temporal gyrus, and occipital lobe in response to images depicting parental affection and increased activity of the middle frontal and inferior parietal in response scenes from on-line games, relative to healthy comparison subjects. Improvement in perceived family cohesion following 3 weeks of treatment was associated with an increase in the activity of the caudate nucleus in response to affection stimuli and was inversely correlated with changes in on-line game playing time. With evidence of brain activation changes in response to on-line game playing cues and images depicting parental love, the present findings suggest that family cohesion may be an important factor in the treatment of problematic on-line game playing.

1. Introduction

1.1. Family structure and family therapy in adolescents with addiction

An association between dysfunctional family structure and adolescent substance use has been suggested by several public health studies (Frojd et al., 2007; Roustit et al., 2007). In a smoking survey involving 32,961 youth, smoking, alcohol, and drug use were associated with non-intact families (Mak et al., 2010). Moreover, a perceived lack of family closeness and love has been suggested to increase the risk of health threatening behavior, such as drug taking in adolescents (Reynolds and Rob, 1988). In a study of family factors contributing to internet addiction, Yen et al. (2007) reported that higher levels of parent-adolescent conflict and lower family function were associated with internet addiction. China's "left behind children," due to parental migration from rural to urban areas for work, have been reported to be at increased risk of physical inactivity, internet addiction, and smoking (Gao et al., 2010). In a study of 1369 university students, Tsai et al. (2009) reported that deficient social support was a significant risk factor for internet addiction. Further, loneliness and familial discord have also been reported to lead to internet addiction (Young, 1996; Nalwa and Anand, 2003).

Although there is some controversy in terms of the feasibility of providing treatment, family therapy has been suggested for patients with substance dependence (Crane, 2007; Morgan and Crane, 2010). Compared to a psychoeducational drug treatment intervention, integrated family and cognitive behavior therapy has been reported to reduce rates of marijuana use and improve problem solving and learning strategy skills in adolescents with substance dependence (Latimer et al., 2003). Parental monitoring and interest in their children has also been reported to be important for the treatment and management of adolescents with internet addiction (Lin et al., 2009). Young (2009) have emphasized that parental efforts such as limit setting with respect to playing time and switching computer usage from game playing to doing homework are important elements for the treatment of adolescent internet addiction. In addition, family therapy modified by short-term Brief Strategic Family Therapy for substance addiction is useful in reducing compulsive gaming in adolescents (Robbins et al., 2011).

1.2. Similar brain activity in response to affection and addiction

In spite of results demonstrating that family therapy is effective for the treatment of adolescents with addiction, there are few published

* Corresponding author at: Brain Institute, University of Utah, 383 Colorow Drive, Room 309, Salt Lake City, UT 84108, United States. Tel.: +1 801 587 1216; fax: +1 801 585 5375.
E-mail address: perry_renshaw@yahoo.com (P.F. Renshaw).

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studies demonstrating brain changes induced by family focused therapy in patients with substance dependence. In contrast, there have been several studies of brain activity in response to romantic or parental love and affection. These studies have noted a correlation between stimuli depicting love or interpersonal attachment and brain activity in frontal cortex and striatum (Bartels and Zeki, 2004; Taylor et al., 2009; Frascella et al., 2010). Notably, these same brain regions also respond to drug cues in cohorts of drug dependent subjects and several investigators have noted that love and addiction share similar characteristics (Fisher et al., 2005; Frascella et al., 2010). For example, a lover's intense interest in a preferred individual, unstable mood, craving, obsession, compulsion, distorted reality, and loss of self-control parallel similar findings in drug users (Griffin-Shelley, 1991; Mellody et al., 1992). Based on the observation of increased activation in the right ventral tegmental area and right caudate nucleus in response to images of beloved others, Fisher et al. (Fisher et al., 2005) suggested that dopaminergic reward pathways may be linked to the recognition of romantic love. Compared to unfamiliar faces, increased activation in the parahippocampal gyrus, middle superior temporal gyri and middle frontal gyrus were observed in response to images of partner faces (Taylor et al., 2009). Bartels and Zeki (2004) have reported activation of the caudate nucleus in response to images depicting maternal love and romantic love in healthy subjects.

Interestingly, prefrontal cortex and subcortical areas may also mediate responses to video game play (Koepp and Silver, 1998; Matsuda and Hiraki, 2006). In a near infrared spectroscopy (NIRS) study of thirteen children and adolescents (7–14 years old), a sustained decrease of oxygenated hemoglobin in the bilateral dorsal prefrontal cortex was observed during video game play (Matsuda and Hiraki, 2006). Koepp and Silver (Koepp and Silver, 1998) have noted a release of dopamine in the thalamus during game play. Recent fMRI studies of on-line game play have suggested that the brain activation observed in response to on-line game cues may be similar to that observed in patients with substance dependence who are exposed to drug cues (Ko et al., 2009; Han et al., 2011). Ko et al. (2009) have reported that patients with on-line game addiction show increased activity in dorsolateral prefrontal cortex, orbitofrontal cortex, anterior cingulate, nucleus accumbens, and caudate nucleus, in response to on-line game cues compared with activation patterns observed in healthy volunteers. Our previous fMRI study (Han et al., 2011) also reported that the craving for on-line game play in response to on-line game cues was associated with the beta values for clusters of activation within the left inferior frontal gyrus, left parahippocampal gyrus, and right thalamus in response to on-line game cues in healthy volunteers.

1.3. Hypothesis

In the current study, based on published findings, we evaluated whether a brief 3-week family therapy intervention would change patterns of brain activation in response to affection and gaming cues in adolescents from dysfunctional families who met criteria for on-line game addiction.

2. Method

2.1. Subjects

From adolescents and their parents who visited the Department of Psychiatry of Chung Ang University Medical Center for evaluation and treatment of possible on-line game addiction, fifteen families with moderate to severe family dysfunction agreed to participate in this study. Dysfunctional families were defined as having Family Adaptability, Partnership, Growth, Affection, and Resolve (FAPGAR) scores (Smilkstein, 1978, 1980) of less than 3; an adaptability score on the Family Adaptability and Cohesion Evaluation scale (FACES III) (Olson, 1986, 1991) of less than 24; and a cohesion score on FACES III of less than 40. In addition, the criteria for problematic on-line game play were 1) game playing time greater than four hours per day and 30 hours per week (Ko et al., 2009; Han et al., 2010): 2) Young Internet Addiction Scale (YIAS) scores (Young, 1996; Yoo et al., 2004; Ha et al., 2006) greater than 50. In an epidemiology study of Korean school students, Yoo et al. (2004) reported that 14% of students met the criteria of problematic internet addiction using a standard of IAD > 50. ; and 3) impaired behaviors or distress due to excessive on-line game play which are modified from DSM-IV criteria for substance abuse (American_Psychiatric_Association, 2000). For the screening of other psychiatric problems, the Structured Clinical Interview for DSM-IV and the Beck Depression Inventory (BDI) were administered (Beck et al., 1961). Exclusion criteria included: (1) adolescents with a history or current episode of psychiatric disease; (2) adolescents with a history of substance abuse or dependence including alcohol and tobacco; (3) adolescents with neurological or medical disorders; and (4) adolescents with a contraindication to MRI scanning such as claustrophobia and metal implants. Fifteen healthy comparison families were recruited by word of mouth and using flyers posted within Chung Ang University seeking healthy families with adolescent children. The research protocol was approved by the Chung Ang University Hospital Institutional Review Board. Written informed consent was provided by all adolescents and their parents.

There were no differences in terms of age (the adolescents with problematic on-line game play: 14.2 ± 1.5 years; healthy comparison subjects: 14.0 ± 1.3 years, $z = 0.61$, $p = 0.54$) and years of education (the adolescents with problematic on-line game play: 7.5 ± 1.8 years, healthy comparison subjects: 7.0 ± 1.3 years, $z = 1.08$, $p = 0.28$). Between the two groups, there were significant differences in terms of YIAS scores ($z = 4.12$, $p < 0.01$), total game playing time ($z = 3.98$, $p < 0.01$), and FAPGAR scores ($z = 3.21$, $p < 0.01$). The mean time of video game play in 15 adolescents with on-line game addiction (34.5 ± 9.6 hours/week) and in 15 healthy comparison (3.1 ± 1.7 hours/week) were recorded by patients themselves and confirmed by parental report. The mean YIAS scores of adolescents with on-line game addiction and healthy comparison subjects at baseline were 75.1 ± 11.2 and 34.5 ± 9.6, respectively. The mean FAPGAR scores for adolescents with on-line game addiction and healthy comparison subjects at baseline were 2.5 ± 1.5 and 5.8 ± 1.8, respectively.

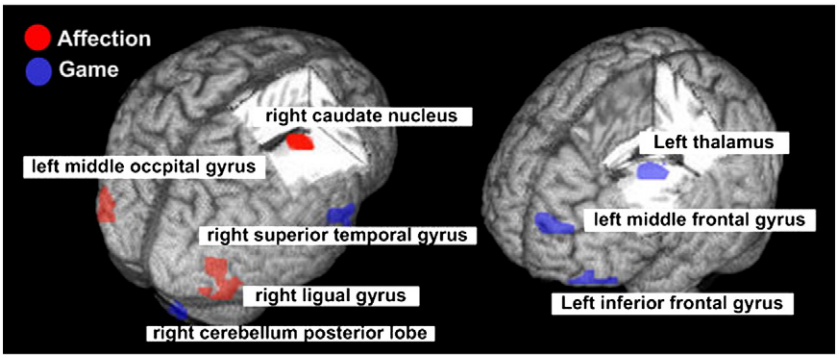

Fig. 1. Interaction between group (subjects vs. controls) and stimuli (affection/game vs. neutral) in response to affection/game at baselineI. Affection: Interaction between group (adolescents with on-line game addiction vs. controls) and stimuli (affection vs. neutral) in response to affection at baseline, FDR < 0.05, $p < 0.005$; right caudate body: Talairach x, y, z; 7, 2, 15; right occipital lingual gyrus: 29, −66, −2, Brodmann area (BA) 19; left middle occipital gyrus: −39, −67, 4, BA37. Game: Interaction between group (adolescents with on-line game addiction vs. controls) and game stimuli (game vs. neutral) in response to game at baseline, FDR < 0.005, $p < 0.003$; left thalamus: −10, −24, 10; left middle frontal gyrus: −27, 44, 9, BA 10; left inferior frontal gyrus: −36, 18, −6, BA 47.