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Impairments of facial emotion recognition and theory of mind in methamphetamine abusers

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ABSTRACT

Chronic use of methamphetamine is related to behavioral disturbances including depression, aggressive behavior, and social isolation. These alterations of social behavior may be attributable to impairments in social cognition. However, few studies have evaluated social cognition in methamphetamine (MA) abusers. Therefore, the aim of the present study was to investigate whether MA abusers exhibit social cognition deficits in terms of facial emotion recognition and theory of mind (ToM). We also assessed cognitive flexibility by using the Wisconsin Card Sorting Test (WCST) to evaluate the impact of this function on social cognition. Twenty-eight MA abusers and twenty-seven healthy subjects enrolled in this study. All participants performed the Facial Emotion Recognition Task and advanced ToM tasks such as the Eye Test and Hinting Task. The Korean Wechsler Adult Intelligence Scale—Revised and computerized versions of the WCST were also administrated. The performances of MA abusers on the Facial Emotion Recognition Task and Eyes Test were lower than those of healthy subjects. In the WCST, MA abusers completed significantly fewer categories and made more total and perseverative errors than healthy subjects did. In addition, impairments in cognitive flexibility are correlated with impairments in facial emotion recognition and ToM within MA abusers. These findings lend further support to the assertion that the capacity to identify emotions from facial expression and infer mental state of others is impaired in MA abusers. Therefore, treatment and rehabilitation for MA abusers must consider role of social cognition and include relearning social interactions and behaviors.

1. Introduction

Methamphetamine (MA) causes euphoria, increased energy, and enhanced self-confidence and sociability (Homer et al., 2008), and its abuse has been increasing worldwide (Shaw, 1999; Maxwell and Rutkowski, 2008). Relatively low doses taken orally may result in behavior within normal limits. At higher doses, however, common disruptions in behavior include hyperactivity, restlessness, short-tempered behavior, and severely aggressive behavior (Cohen et al., 2003; Newton et al., 2004). Such behavioral changes in MA abusers may lead to social isolation.

These alternations of behavior may be attributable to impairments in social cognition (Homer et al., 2008), which is thought to be processed in the prefrontal cortex. Mounting evidence from neuroimaging studies supports the view that MA abusers have various kinds of abnormalities in the prefrontal cortex (Ernst et al., 2000; Volkow et al., 2001; Nordahl et al., 2002; Paulus et al., 2002, 2003; Sekine et al., 2003, 2006; London et al., 2004; Kim et al., 2005, 2006). Therefore, chronic administration of MA results in neurological damage to the prefrontal cortex, leading to impaired social-cognitive functioning, which in turn may contribute to the behavioral problems described above (Homer et al., 2008).

The concept of social cognition refers to a relatively large number of psychological constructs ranging from emotion perception to theory of mind (ToM), which refers to our ability to explain and predict the behavior of ourselves and others by attributing to them independent mental states, such as beliefs, desires, emotions, or intentions (Gallagher and Frith, 2003). Substance abuse has also been shown to be associated with a range of social cognition impairments. The decoding of emotional facial expression is impaired in alcohol abusers (Philippot et al., 1999; Kornreich et al., 2001, 2003; Townshend and Duka, 2003; Foisy et al., 2005, 2007; Uekermann et al., 2005), and these deficits tend to persist after months of abstinence. A selective deficit in fear recognition is manifested in regular recreational cocaine users compared with cocaine-naïve participants and

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occasional users (Kemmis et al., 2007). While a relatively broad database exists with respect to emotion perception in faces, little is known regarding ToM in drug abusers.

To the best of our knowledge, only a handful of studies have examined both facial emotion recognition and ToM in MA abusers. Payer et al. (2008) demonstrated that MA abusers showed less task-related activity than did healthy subjects in cortical areas including the ventrolateral prefrontal cortex, temporoparietal junction, anterior and posterior temporal cortex, and fusiform gyrus during a facial affect matching task. Henry et al. (2009) found that MA users who engaged in rehabilitation and were abstinent for an average period of 6 months showed impairment in the measures of facial affect recognition and ToM. Thus far, however, no study has directly tested whether recently abstinent MA abusers have impairment in facial emotion recognition and ToM. Therefore, the first aim of the present study was to access social cognition deficits by administering both the Facial Emotion Recognition Task (Silver et al., 2004) and advanced ToM tasks such as the Eye Test (Baron-Cohen et al., 2001) and Hinting Task (Corcoran et al., 1995), which are reported to be more sensitive to subtle ToM deficits. Considering altered social behavior and prefrontal abnormalities in MA abusers, we hypothesized that relative to healthy subjects, MA abusers would be impaired with regard to both facial emotion recognition and ToM. The second aim of this study was to explore the relationship between social cognition and cognitive flexibility within MA abusers. To investigate the impact of cognitive flexibility on social cognition, we also examined the performance of MA abusers in the Wisconsin Card Sorting Test (WCST).

2. Methods

2.1. Participants

Twenty-eight MA abusers and twenty-seven healthy subjects were enrolled in this study. All MA abusers were recruited from the Drug Abuse Center, Bugok National Hospital, Korea, based on consensus diagnoses by two licensed psychiatrists, according to the DSM-IV criteria for drug abuse. Among all MA abusers, five patients also met the DSM-IV criteria for dependence on methamphetamine. To control for gender bias, only male subjects were selected. Exclusion criteria included past neurological illness or traumatic brain injury, mental retardation, other substance use except caffeine and/or nicotine, and lifetime axis I psychiatric diagnoses other than MA abuse. We defined social alcohol drinking as drinking fewer than five drinks per occasion on fewer than 5 days in the past 30 days. To ensure that subjects were drug-free at the time of testing, all MA abusers underwent a urine test after at least one week of abstinence.

Healthy subjects were recruited as volunteers in the neighboring towns around Bugok National Hospital, and were selected based on similarities in age, sex, and educational background to the MA abusers. Healthy subjects had psychiatric interviews to rule out neurological and psychiatric disorders. They were excluded if they suffered from a neurological condition such as seizure, stroke, or head injury, or an Axis I psychiatric diagnosis except caffeine and/or nicotine dependence. The healthy subjects also performed a urine test to exclude drug abuse.

All subjects from both groups gave written informed consent, as approved by the Institutional Review Board (IRB), after receiving a detailed explanation of the research and experimental procedures. The IRB of Bugok National Hospital approved all experimental procedures for this study.

2.2. Procedures

All of the subjects attended an initial session for evaluation of social cognition, such as facial emotion recognition and ToM. All participants then had a rest period at the end of the initial session to prevent fatigue or boredom from affecting their performance in the tests that followed. After the rest, subjects underwent the Korean Wechsler Adult Intelligence Scale—Revised (Yum et al., 1992) and computerized versions of the WCST. Each session lasted approximately 1 h. All participants were prohibited from smoking and drinking coffee for 4 h before the tests. They also completed the Beck Depression Inventory (BDI; Beck et al., 1961), a self-rating questionnaire that assesses current depressive symptoms.

2.2.1. Facial Emotion Recognition Task

The Facial Emotion Recognition Task (Silver et al., 2004) comprises 40 color photographs of faces expressing one of four basic emotions (happiness, sadness, anger, or fear) or showing a neutral expression. The participant's task is to choose one of the five options. The performance was measured by the number of correct responses.

2.2.2. Eyes Test

The revised version of the Reading the Mind in the Eyes Test was administered (Baron-Cohen et al., 2001). This task is considered an advanced ToM test because participants are required to attempt to put themselves into the mind of the person shown in the photograph, and attribute a relevant mental state to him/her. Participants were presented with a series of 36 photographs of the eye region of the face of different actors and actresses. Four complex mental state descriptors (e.g., dispirited, bored) were printed around the photo, one at each corner. Participants were instructed to choose which of the four words best described what the person in the photo was thinking or feeling. The test was scored by totaling the number of photographs correctly identified by the participant. We translated four complex mental state descriptors into the Korean language and adapted the test for Korean healthy subjects (Hur et al., 2006).

2.2.3. Hinting Task

The Hinting Task is a test of the ability of subjects to infer the real intentions behind indirect speech utterances. In the original version of the task (Corcoran et al., 1995), 10 short stories describe interaction between two characters and end with one character hinting to the other. The participant is asked what the character really meant. An appropriate answer is given two points. If the answer is wrong, further information is given to the participant. An appropriate answer is given one point. We chose eight stories from the hinting task for use in the present study because two stories were not relevant to Korean culture. Eight stories were translated into the Korean language and adapted for Korean healthy subjects (Hur et al., 2006).

2.2.4. Wisconsin Card Sorting Test

The computerized version of the WCST (Heaton, 1993), a commonly used measure of cognitive flexibility, was administered. The subjects sort response cards until they have matched six categories or sorted all 128 cards. Cards are matched according to different dimensions such as color, form, and number. After 10 consecutive correct card sorts, a new sorting principle is instituted without warning. Measures of performance include the number of categories completed, and perseverative errors, which are considered to reflect dorsolateral prefrontal cortex function.

2.3. Data analysis

The independent-sample *t*-test and the chi-square test were used to compare the demographic characteristics and performance in neuropsychological tests between the two groups. Correlational analysis was used in the MA abusers group to additionally examine the relationships among social cognition, cognitive flexibility, and clinical variables. A p value of less than 0.05 was considered statistically significant. To reduce the type I errors of neuropsychological tests, interpretations of significant findings were based on a *t*-test of each domain with Bonferroni correction for multiple comparison.

3. Results

Demographic characteristics of MA abusers and healthy subjects are summarized in Table 1. There were no significant differences with respect to age ($t=-0.873$, $df=38.71$, $p=0.38$), education level ($t=1.46$, $df=53$, $p=0.14$), or IQ ($t=0.77$, $df=53$, $p=0.44$) between MA abusers and healthy subjects. The BDI scores of MA abusers were not different from those of healthy subjects ($t=-1.058$, $df=53$, $p=0.29$). There were no significant differences regarding the prevalence of social alcohol drinking (chi square $=-0.982$, $df=1$, $p=0.32$) or current cigarette smoking (chi square $=-3.183$, $df=1$, $p=0.07$) between MA abusers and healthy subjects. In the MA abusers group, the age of initial MA use was 26.89 ± 6.37 years, the duration of MA use was 13.93 ± 7.76 years, the total cumulative dose of MA was 311.07 ± 224.25 mg, and the period of abstinence was 19.46 ± 7.86 days.

Table 2 lists the results of analysis by the independent-samples *t*-test for differences between the groups regarding performance in the Facial Emotion Recognition Task, Eyes Test, Hinting Task, and WCST. In the Facial Emotion Recognition Task, MA abusers performed poorly relative to healthy subjects ($t=3.03$, $df=34.67$, $p=0.004$). Specifically, recognition of fearful expression was poorer in MA abusers than in healthy subjects ($t=3.22$, $df=39.54$, $p=0.003$), while there was no significant difference between the groups regarding happy, sad, angry, and neutral face recognition. The performance of MA abusers in the Eyes Test ($t=3.75$, $df=53$, $p<0.001$) and Hinting Task ($t=2.09$, $df=37.371$, $p=0.04$) was lower than that of healthy subjects. Significant differences were found between the two groups in terms of WCST performance. MA abusers completed significantly fewer categories ($t=5.25$, $df=42.16$, $p<0.001$) and made more total ($t=-6.17$, $df=53$, $p<0.001$) and perseverative errors ($t=-3.62$, $df=53$, $p=0.001$) than did the healthy subjects. With the exception of the Hinting Task, these significant differences persisted after Bonferroni correction.