Effect of acute mild exercise on fear extinction: Role of hippocampal BDNF

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BACKGROUND:

Psychological disorders such as phobias, major depressive disorder (MDD) and post-traumatic stress disorder (PTSD) have increased in our highly-stressed modern society. The relevance of fear extinction has become even more significant in recent Japan after the Great East Japan Earthquake and Tsunami.

Physical exercise is well known to benefit our brain functions, such as learning and memory. It has also been reported that exercise as an antidepressant could be an effective and cost-efficient treatment alternative for a variety of anxiety disorders (Carek et al., 2011). One molecule that may be involved in the anti-depressive effect of exercise is brain derived neurotropic factor (BDNF). A recent study showed that the anti-depressive effect of voluntary wheel running correlates with increased hippocampal BDNF in the depression model of mice (Sartori et al., 2011). Growing evidence also indicated that stress decreases the expression of BDNF in limbic structures and antidepressants exert the opposite effect in limbic brain regions involved in the regulation of mood and cognition (Duman and Monteggia, 2006). However, little is known about the BDNF effect on fear extinction.

One recent study has demonstrated that BDNF infused into the infra-limbic system reduced conditioned fear for up to 48 hours (Peters et al., 2010). It is noteworthy that the BDNF was administered immediately before the extinction test, which may further suggest that even acute effect of BDNF could be involved in the process of fear extinction. Additionally, previous reports, including ours, have already showed that acute mild exercise increases hippocampal BDNF levels (Huang et al., 2006; Soya et al., 2007). Thus, it is plausible to hypothesize that acute mild exercise is able to accelerate fear extinction through infra-limbic BDNF action in rats.

METHODS:

To test this hypothesis, acute mild exercise was applied to normal Wistar rats, according to our previous protocol (Soya et al., 2007) and the hippocampal BDNF levels were examined at pre-exercise (Pre), 0hr, 1hr, 2hr, and 6hr after exercise. After the determination of the BDNF peak time point, another set of rats were trained by contextual fear conditioning, and then tested for fear extinction at a chosen time point after exercise.

RESULTS:

The current data revealed that 1) the hippocampal BDNF was increased immediately and at 1hr after acute mild exercise, while 1hr after exercise showed highest expression of BDNF; 2) Acute mild exercise significantly decreased freezing behavior during the fear extinction test, which suggests the accelerative effect on the extinction of fear memory.

DISCUSSION:

Our current data may indicate that increased hippocampal BDNF was highly related to the accelerated fear extinction process after acute mild exercise and may become the basis for analyzing the molecular mechanisms of exercise-altered fear extinction.

References