Meta Analysis of the Relationship between ADHD Children and Creativity

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ABSTRACT
The creativity of attention deficit hyperactivity disorder (ADHD) has been widely proved in all stages of human development. School-age children and adolescents are an important period for the development of creativity level. The relationship between the creativity level of school-age children and adolescents and the symptoms of ADHD is still controversial. This paper aims to explore the relationship between children with attention deficit hyperactivity disorder and their creativity at home and abroad, so as to provide a theoretical basis for improving their mental health. Through searching the academic databases of CNKI and Google, the relationship between ADHD children and creativity level was analyzed by meta-analysis. Four original literatures were included in the meta-analysis, with a total sample of 129 people. This paper finds that there is heterogeneity in the correlation between ADHD and torrenster creative power scale score ($I2 = 84\%$, $P < 0.05$). Torrenster creative power scale score of ADHD was slightly higher than that of non ADHD group, but the difference was not statistically significant. It was not considered that torrenster creative power scale score of ADHD was different from that of non ADHD group.

Keywords: *ADHD children, attention deficit hyperactivity disorder, creativity, meta-analysis*

1. INTRODUCTION

Attention Deficit/Hyper activity Disorder (ADHD) is a common developmental disorder characterized by persistent attention deficit, hyperactivity/impulsivity [1]. In China, the prevalence of ADHD has been increasing with socioeconomic development in recent years, and has gained increasing attention because of its high co-morbidity and high risk [2-3]. Although ADHD is usually diagnosed in childhood, its symptoms often persist into adulthood, and in recent years, public's attention has been drawn to adult ADHD due to the considerable problems caused by this disorder. ADHD is associated with impairments of academic and occupational functioning, and it also increases the risk of depression, anxiety and addiction. However, ADHD may benefit when creativity is needed under certain circumstances. Quantities of previous scientific studies have shown a strong correlation between ADHD and creativity, and that the ADHD group is more creative than the general population, mainly in terms of non-trivial creativity. A large number of studies have demonstrated executive functioning deficits in school-age children with ADHD and adults with ADHD, but the level of creativity is controversial and deserves further investigation.

Recent findings on creative cognition and functional brain networks suggest that the production of creative thinking is characterized by the interplay between the default network (DN) and the executive control network (ECN). DN is a set of cortical midline and inferior parietal regions that activate during cognitive processes such as episodic and semantic memory retrieval, and mental simulation, which involve self-referencing and self-generated thought. The ECN, comprised of lateral prefrontal and anterior inferior parietal regions, supports cognitive control processes such as reactive inhibition, goal maintenance, and attentional control. In the course of creative task execution, the DN and ECN may reflect goal-directed and self-directed cognition. The DN is involved in idea generation and influences the creation of potential ideas; the ECN plays a role in

directing, disciplining, and modifying the DN process to achieve the goal of the creative task. Through top-down monitoring and execution control, task-specific objectives are met (Figure 1).

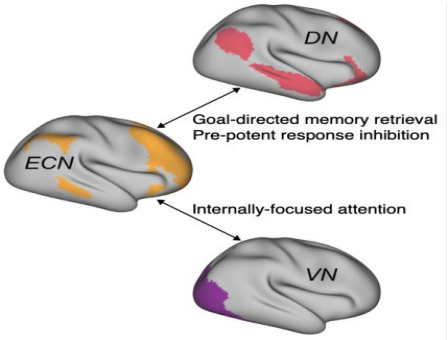

Figure 1. Interactions among brain networks in creative cognitive processes [4]

The DN of ADHD is often overactive. People with ADHD sometimes get into the state of mind-wandering in daily life while DN is still activating. Nevertheless, creativity is closely connected with the DN, take Openness to Experience as an example. Openness to Experience is a very dominant creative personality trait that is highly correlated to ADHD and is characterized by a preference for imaginative, creative, and abstract thinking, as well as curiosity about new things and active exploration of the environment in which it was created. In summary, creative cognitive processing is extremely complex and requires highly effective synergistic brain dynamics. People with ADHD have different patterns of brain connectivity and different levels of activation and arousal of certain brain networks when compared with the general public, which provide some unusual space for creative thinking to develop.

2. THE PREDICTABILITY OF THE LEVEL OF CREATIVITY AND ADHD SYMPTOMS

Holly White conducted a study that recruited two groups of participants, a group of participants with ADHD and a group of non-ADHD university students. The researchers asked both groups of participants to create “alien fruits” which were fruits that were completely different from fruits on earth and probably existed on another planet. The results indicated that most non-ADHD participants constructed their work based on the appearance of some common fruits on earth (e.g. apple & strawberry), which were perceived as less creative work [5, 6]. In conclusion, people with ADHD are more likely to think from unexpected angles and generate more original ideas.

In a study that investigated subclinical ADHD and creativity, researchers found that the association between subclinical ADHD symptoms and enhanced creativity was mainly driven by hyperactive/impulsive ADHD symptoms. That was, people with ADHD are more impulsive and hypersensitive to positive and rewarded stimuli. They also tended to be novelty-seeking and engaged in risk-taking behaviors compared to people without ADHD. These characteristics are closely related to their process of creative thinking. What’s more, their disturbed ways of thinking also highlight their divergent and unconventional ways of thinking. All of these specific characteristics are closely related to creative thinking. Consistent with these findings, this study hypothesized that people with ADHD would perform better on creativity than the controls.

3. METHODOLOGY

3.1. Data collection

This paper is conducted based on two databases which were the China National Knowledge Infrastructure database (CNKI) and google scholar. "ADHD", "ADHD children", "Attention deficit hyperactivity disorder", "Creativity", "Creativity level", "TTCT" were keywords combined for systematic searching. The search period was limited to 2005-2020, and the latest literature retrieved has a publication date of 2017. According to the searching strategies, through browsing titles and abstracts, the selected literature was further reviewed to ensure the correlation. Among the literature searched, the number of patients who participated in previous experiments was 129. The quality of the included literature was assessed using the literature evaluation criteria of the Australian Evidence-Based Health Care Center JBI (2016). The evaluation result was shown in Table 1.

Table 1. Quality evaluation results of included literature [7-10]

Included literature	1	2	3	4	5	6	7	8
Gracia	yes	yes	yes	yes	no	no	yes	yes
Banafsheh	yes	yes	yes	yes	yes	no	yes	yes
Dione	yes	yes	yes	yes	yes	no	yes	yes

Dione	yes	yes	yes	yes	yes	no	yes	yes

Note: (1) Whether the inclusion criteria of the sample are clearly defined; (2) Whether the research objects and research sites are described in detail; (3) Whether the measurement methods of exposed factors are reliable and valid; (4) Whether there are objective and consistent standards for the definitions of disease or health problems; (5)Whether confounders have been identified; (6) Whether measures have been taken to control confounders; (7) Whether outcomes measures are reliable and valid; (8) whether the methods of data analysis are appropriate.

3.2. Data inclusion criteria

Inclusion criteria: data collected from test participants who are clearly diagnosed as ADHD or with ADHD symptoms; data which provide statistical information that can calculate the effect value, such as sample size, mean, standard deviation, and p value, can be applied to obtain scoring indicators. This study does not include regression analysis; the same literature used for the longitudinal study, reporting the first Torrenster Creativity Scale measure Test data and the last ADHD symptom data; if the same research data were published multiple times, then the latest publication would be selected.

Table 2. Quality inspection

Title	Author	Year	en	emean	esd	cn	cmean	csd
Creativity in Children with Attention Déficit Hyperactivity Disorder (ADHD)	Gracia	2017	34.00	109.97	13.54	34.00	94.79	13.29
An Investigation Into The Relationship Among ADHD Symptomatology, Creativity, And Neuropsychological Functioning In Children	Dione	2006	29.00	37.83	30.48	30.00	45.97	23.37
Comparison of Creativity between Children with and without Attention Deficit Hyperactivity Disorder: A Case	Banafsheh	2016	33.00	125.20	42.60	33.00	130.60	47.50
An Exploration Into the Creative Abilities of Children With ADHD	Dione	2005	33.00	49.06	30.04	34.00	50.00	27.61

3.3. Data processing

RevMan5.5. is applied for Meta Analysis with the advanced value of software indicators and 95% as the execution volume.

A heterogeneity test was conducted. When I2≥50% and (or) P<0.1, indicating the included articles have a relatively high heterogeneity, and the random effect model is applied.

When I2<50% and (or) P≥0.1, it indicates that the inputted articles have a relatively low heterogeneity, and the fixed model is used.

Sensitivity analysis would be performed on the literature with higher heterogeneity, and the risk factor groups within more than two papers would be eliminated thereby ensuring the stability of the results.

3.4. Results

3.4.1. Testing for publication bias

The Egger's test (P = 0.5612) showed that there may be no publication bias, but the leakage plot found the basis of scatter distribution is asymmetric, with obvious outliers, which suggesting that the included studies may have publication bias.

3.4.2. Main Effects and Heterogeneity Test

The heterogeneity test eliminated that the correlation between ADHD and TTCT score of the 4 studies included in the meta-analysis was heterogeneous (I2=84%, P<0.05), so a random effect model was applied for meta-analysis. The results showed that the TTCT score of ADHD is slightly higher than the non-ADHD group, but the difference was not statistically significant (SMD0.17, 95%CI, -0.46-0.79, P=0.6040), so the TTCT score of ADHD was not considered to be different from the non-ADHD group, as shown in Figure 2.

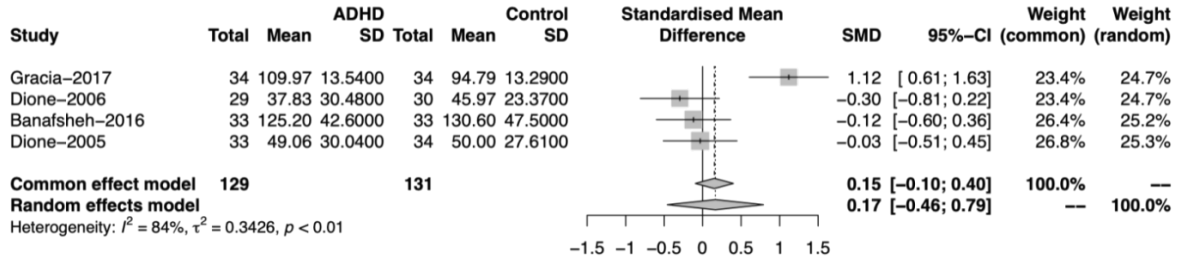

Figure 2. Correlation Analysis between ADHD and TTCT score

4. DISCUSSION

The researchers put forward the following points about how to raise creativity in ADHD patients: Break the limitation of thinking, and do not think too much about suitability. In the process of creative thinking, it is worth encouraging to think out first, regardless of whether there is any advantage or not. The semantic distance of ADHD is far away because of its thinking style and long-term slow thinking (wandering), so it is very creative.

5. CONCLUSION

There is heterogeneity in the correlation between ADHD and Torrance creativity scale score (I2=84%, P<0.05). It is not considered that there is a difference between the Torrance creativity scale score of ADHD and non-ADHD group. Thus the relationship between ADHD children and creativity level is not close.

AUTHORS' CONTRIBUTIONS

This paper is completed by Xiaotong Zhu, Hanqi Zheng, Kedi Chen, Yixuan Zhang, Yuying Liu. Xiaotong Zhu completed the research framework, data collection and analysis and thesis writing, while the rest completed literature reading and some thesis writing.

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