The Comparisons of the Development of Scientific Creativity between English and Chinese Adolescents*

Weiping Hu
Shanxi Teachers' University, China
Jiliang Shen
Chongde Lin
Beijing Normal University, China
Philip Adey
King's College London, UK

Abstract

This study administered the Scientific Creativity Test for Secondary School Students to 1190 adolescents aged 11 to 15 from 6 suburban mixed comprehensive schools in England and 1087 adolescents aged 12 to18 from 2 suburban middle schools (one is key-middle-school, and another is ordinary-middle-school) in China. Result indicated that: (1) the age difference of scientific creativity of adolescents is marked. It has increasing tendency, but decreases at 14. The key periods for the rapid development of adolescents' scientific creativity are from 11 to 13 and from 14 to 16 years old. The scientific creativity becomes fixed at 17 years old. (2) The scientific creativity of adolescents has sex difference. English females' scientific creativity is evidently superior to males'. But Chinese males' scientific creativity is superior to females', and the difference is not remarkable. Based on this result and other studies, we proposed the culture model of sex difference of scientific creativity. (3) There is marked difference in scientific creativity between Chinese and English adolescents. Chinese adolescents' creative problem solving ability is evidently superior to that of English adolescents. But English adolescents' other scientific creativity and whole scientific creativity are evidently superior to that of Chinese adolescents. (4) There is marked difference in scientific creativity among students in different kind of Chinese schools. Key-middle-school-subjects' scientific creativity is evidently superior to that of ordinary-middle-school-subjects. The authors think school environment and school education are more important than school type to the development of scientific creativity.

作者：胡卫平，山西临汾：山西师范大学课程与教学研究所，邮编：**041004**
Email：**huwp@dns.sxtu.edu.cn**，电话：**0357-2051166**（**o**）**0357-2051763**（**h**）
林崇德、申继亮，北京师范大学发展心理研究所，邮编：**100875**， 电话：**010-62207731**（**o**）
Philip Adey, 伦敦大学国王学院，英国。

The Comparisons of the Development of Scientific Creativity

* **This study is supported from funding by Chinese National Education planning Office and Shanxi Scholarship Council.**

between English and Chinese Adolescents*

Abstract

This study administered the Scientific Creativity Test for Secondary School Students to 1190 adolescents aged 11 to 15 from 6 suburban mixed comprehensive schools in England and 1087 adolescents aged 12 to18 from 2 suburban middle schools (one is key-middle-school, and another is ordinary-middle-school) in China. Result indicated that: (1) the age difference of scientific creativity of adolescents is marked. It has increasing tendency, but decreases at 14. The key periods for the rapid development of adolescents' scientific creativity are from 11 to 13 and from 14 to 16 years old. (2) The scientific creativity of adolescents has sex difference. English females' scientific creativity is evidently superior to males'. But Chinese males' scientific creativity is superior to females', and the difference is not remarkable. Based on this result and other studies, we proposed the culture model of sex difference of scientific creativity. (3) There is marked difference in scientific creativity between Chinese and English adolescents. Chinese adolescents' creative problem solving ability is evidently superior to that of English adolescents. But English adolescents' other scientific creativity and whole scientific creativity are evidently superior to that of Chinese adolescents. (4) There is marked difference in scientific creativity among students in different kind of Chinese schools. Key-middle-school-subjects' scientific creativity is evidently superior to that of ordinary-middle-school-subjects. The authors think school environment and school education are more important than school type to the development of scientific creativity.

Key words: development scientific creativity English adolescents Chinese adolescents comparison

* **This study is supported from funding by Chinese National Education planning Office and Shanxi Scholarship Council.**

Introduction

Various creativity studies have been conducted over the past several decades. However, previous researches on creativity have mostly focused on creativity as a general ability or process (Hennessey & Amabile, 1988; Richardson & Crichlow, 1995; Sternberg, 1988; Taylor, 1988; Treffinger, 1995). This general lack of attention to domain-specific components does not only limit our understanding of creativity but may also have serious educational implications. It is highly unlikely that these research results as well as instructional methods designed to increase general creativity levels will be equally effective when they are used for specific domains, such as science. With respect to the development of creativity, although there are some researches about the development of general creativity of adolescents (Torrance, 1962; ***Simonton, 1983***; Runco, 1999), few reports about the development of their scientific creativity can be found.

There is a general consensus that domain-specific knowledge and skills are major components of creativity. Alexander (1992) and Amabile (1987) emphasized the need for specific domain or discipline-based knowledge and skills for creative thinking. This issue was also addressed by Findlay & Lumsden (1988) and Mumford, Mobley, Umlman, Reiter-Palmon, & Doares (1991) who defined being knowledgeable as having a knowledge base that is conceptually well-organized and for which retrieval is fluent and efficient in relation to demand in a given problem-solving or creative thinking situation. Other researchers (Albert, 1983; Feldman, 1986; Gardner, 1983) also concluded that creativity is domain specific. As Barron & Harrington (1981) suggested, more domain-specific aspects of divergent thought may underlie creative productivity. According to his research, Sternberg (1996) concluded that the correlation coefficient of creativity between different areas is only 0.37. Feldhusen (1994) proposed that creative functioning in one domain may be unique and psychologically different from creative functioning in another domain. We can conclude that as a domain-specific creativity, it is necessary for us to study the development of scientific creativity of adolescents.

As to the development of scientific creativity of adolescents, several researches (Shukla & Sharma, 1986; Shi, 1995; Shi, etc., 1998) have been conducted. Although these researches are useful for us to understand the development of scientific creativity of adolescents, they did not give us the developing trend. We also question their applicability in Chinese and English culture since the samples were not Chinese and English adolescents. In addition, the previous studies have contradictory results and lack cross culture research. ***Culture is a major influential factor on scientific creativity. The differences of scientific creativity between different culture can be found through cross culture research. It is helpful for us to understand scientific creativity better.*** The purposes of this study are to find out the developing trend, sex difference of scientific creativity of English and Chinese adolescents, the school difference of scientific creativity of Chinese adolescents, and compare the difference of scientific creativity between English and Chinese adolescents.

The hypotheses is as follows: First, The age difference of scientific creativity of adolescents is marked. It has increasing tendency, but does not increase linearly. Second, The scientific creativity of adolescents has sex difference. Third, There is marked difference in scientific creativity between Chinese and English adolescents. Forth, There is marked difference in scientific creativity among students in different kind of Chinese schools. Key-middle-school-subjects' scientific creativity is evidently superior to that of ordinary-middle-school-subjects.

Method

Subjects

The sample was made up of 1190 adolescents (aged between 11 – 15 years old) come from 6 suburban mixed comprehensive schools with a broad ability range intake in England, ***and 1087 adolescents (aged 12 -18 years old) from 2 suburban middle schools, also with a broad ability range intake, in China. One of the middle schools was a provincial "Key" school, that is one which has close associations with the university. The school record of the students in "Key" schools is better than that in ordinary schools and which is somewhat better resourced than normal. The other***

was an ordinary middle school. The detailed distribution of the sample can be seen in table 1 and table 2.

Table 1. Distribution of age, sex, and school of English subjects

School	Gender	Age					
		11	12	13	14	15	Total
E1	m	61	34	33	21	18	167
	f	45	37	35	18	15	150
E2	m	32	9	13			54
	f	24	10	15			49
E3	m	29	26	26	24	27	132
	f	26	13	25	21	20	105
E4	m	16	26	23	15	10	90
	f	8	27	21	20	17	93
E5	m	27	26	23	28		104
	f	22	23	20	14		79
E6	m	21	37	42	33	24	157
	f	0	10	0	0	0	10
Total		311	278	276	194	131	1190

m: male, f: female

Table 2. Distribution of age, sex, and school of Chinese subjects

School	Gender	Age							
		12	13	14	15	16	17	18	Total
C1 (Ordinary	m	41	37	32	29	37			176
school)	f	35	33	44	33	28			173
C2 (Key	m		58	56	60	159	55	73	461
school)	f		35	41	42	87	37	35	277
Total		76	163	173	164	311	92	108	1087

m: male, f: female

Instrument

The Scientific Creativity Test for Secondary School Students designed by Hu, W. & Adey, P. (2002) is used in this study. ***We define scientific creativity as a kind of intellectual trait or ability producing or potentially producing a certain product that is original and has social or personal value, designed with a certain purpose in mind, using given information. This definition may be elaborated with a set of***

hypotheses about the structure of scientific:

(1) Scientific creativity is different from other creativity since it is concerned with creative science experiments, creative scientific problem finding and solving, and creative science activity.

(2) Scientific creativity is a kind of ability. The structure of scientific creativity itself does not include non-intellectual factors, although non-intellectual factors may influence scientific creativity.

(3)Scientific creativity must depend on scientific knowledge and skills.

(4) Scientific creativity should be a combination of static structure and developmental structure. The adolescent and the mature scientist have the same basic mental structure of scientific creativity but the of the latter is more developed.

(5)Creativity and analytical intelligence are two different factors of a singular function originating from mental ability.

The test, based on the Scientific Creativity Structure Model ***(Hu, W, & Adey, P., 2002)***, and referred to existing general creativity test, especially the Torrance Tests of Creative Thinking, was designed for group administration. The time limit is 60 minutes. Requirements are the same as for other examinations: the examiner seeks to make the students feel at ease but also to work hard to complete the tasks. There is a general instruction printed at the top of the question paper:

> "Today we would like you to demonstrate a very important ability - scientific creativity. You have 7 different tasks. Each task investigates different scientific skills, giving you the opportunity to excel at what you are best at! These tasks will enable you to use your creativity, explore new ideas and solve problems. Please try to complete all the tasks in one lesson (50 or 60 minutes). If you have questions about the tasks, please raise your hand and ask the examiner. Please write your school, year, class, name, sex and today's date on the answer sheet before you begin."

It is suggested that at the outset the teacher or examiner give the entire class a general orientation and ask them to keep their answers secret until all have handed in their answer sheets.

There are 7 items in the test. They are Unusual Uses, Problem Finding, Product Improvement, Creative Imagination, Problem Solving, Science Experiment, and Product Design. Each item measures one aspect of scientific creativity. For each of items 1 to 4, one example of an answer is given to help the students understand what is required.

The scores of task 1 to 4 are the sums of fluency score, flexibility score, and originality score. The fluency score is obtained simply by counting all of the separate responses given by the subjects, regardless of the quality. The flexibility score for each task is obtained by counting the number of approaches or areas used in the answer. The originality score is developed from a tabulation of the frequency of all of the responses obtained. Frequencies and percentages of each response are computed. If the probability of a response is smaller than 5 per cent, we give it 2 points; If the probability is from 5 to 10 per cent, we give it 1 point; If the probability of a response is greater than 10 per cent, we give it 0 points.

The score of task 5 is computed again by tabulating all answers of all subjects, and then rating a particular answer for its rarity value. If the probability is less than 5 per cent, it gets 3 points; for probabilities from 5 to 10, it gets 2 points; If the probability is greater than 10, it gets 1 point. We only have one score for each method of division in task 5. (Most students can get 3 or 4 points; some can get 20 to 30 points. Generally, it is impossible to get 0 points because there are 3 or 4 very simple divisions.

The score of task six is the sum of the flexibility score and the originality score. The flexibility score has a maximum of 9 points for one correct method (instrument: 3 points ; principle, 3 points; procedure, 3 points). The originality score is computed as before: if the occurrence of the method generally is less than 5 per cent, it gets 4 points; if the probability is between 5-10 per cent, it gets 2 points; if the probability is larger than 10 per cent, it gets 0 point. We used a different scoring system in this task because it is more difficult for students to design an original method in testing the napkins than to get an original answer in task 1 to 4.

The score of task seven is decided by the functions of the machine. A particular function of the picking machine could include reaching the apples, finding the apples, picking the apples, transporting the apples to the ground, sorting out the apples, putting the apples in containers, moving on to the next tree. Each function got 3 points. According to the originality, we give a score of 1 to 5 points based on an overall impression having marked all the other scripts.

The Cronbach Alpha coefficient of internal consistency based upon scores of 160 ***England*** adolescents is .893. The inter-scorer reliability varies from .793 to .913 with a median of .875. The re-test reliability varies from .793 to .913 with an overall re-test reliability .916. When factor analysis with principal components was run on the data from this test, only one factor was obtained. This suggested that the test has good construct-related validity. The validity amongst 35 science education researchers and science teachers from China and England is high. The result of x^2 test indicated that $p < .05$ to all of the items. Finally, the test has a satisfactory level of acceptability by the students. The result of x^2 test indicated that $p < .01$ to all of the items.

Procedure

First, the Scientific Creativity Test for Secondary School Students was administered to the sample;

Second, we got the valid test paper based on the accomplishment of the students. The 1087 Chinese students and 1190 English students are the valid sample after getting rid of the invalid test paper. If students could not take the examination seriously or did not work hard to do the tasks, and only play with it, we deleted them as invalid subjects.

Third, all the test papers were marked according to the scoring procedures.

Finally, the data was input and analyzed by SPSS 10.0 for Windows. We investigated the effects of age, sex, and school on each item score and whole test score based on a 5×2 factorial design for English sample and 7×2×2 factorial design for Chinese sample employing MANOVA. Subsequent analyses investigating the differences in each item score and whole test score as a function of age and sex for English sample as well as a function of age, sex, and school for Chinese sample were performed using one-way ANOVA or *t*-test. At last, the difference of development of scientific creativity between English and Chinese adolescents was compared.

Results

The development of scientific creativity of English adolescents

The influences of age and sex to the scientific creativity of English adolescents

In order to explore the influences' main effects and interactions of age and sex to the scientific creativity of secondary school students, we employed MANOVA based a 5 ×2 factorial design. The results indicated that λ is .767 (p<.001) to age, λ is .948 (p<.001) to sex, and λ is .976 (p>.05) to age×sex. The effects of age and sex on each item score and whole test score are summarized in table 3.

Table 3. Results of MANOVA on effects of age and sex on each item and on the whole test for the UK sample (F values)

Source of Variance	Age (*df*=4)	Sex (*df*=1)	Age x Sex (*df*=4)
Unusual Uses	31.937***	1.343	2.110
Problem Finding	28.268***	2.381	0.949
Product Improvement	10.993***	0.016	0.980
Creative Imagination	21.629***	15.331***	0.680
Problem Solving	6.733***	6.126*	0.382
Science Experiment	23.655***	34.314***	1.571
Product Design	7.570***	9.038**	0.533
Whole Test	35.089***	10.482***	0.609

* $p < .05$, ** $p < .01$, *** $p < .001$

From table 3, we have the following conclusion. First, age has significant main effects on the scores of each item and whole test; second, sex has significant main effects on the scores of Creative Imagination, Problem Solving, Science Experiment, Product Design, and whole test; third, there is no interaction between age and sex on the scores of each item and whole test. The result suggested that age and sex might play an important role in the development of scientific creativity of secondary school students.

The age characters of scientific creativity of English adolescents

Because age has significant influence to the scientific creativity of secondary school students, we compared the mean score and standard deviation of subjects in different age on each item and whole test. It is shown in table 4.

Table 4. Mean scores and standard deviation on each item and whole test

Age		11	12	13	14	15
n		255	259	248	194	131
Unusual Uses	*M*	6.00	8.48	9.87	9.54	10.04
	SD	4.09	4.79	4.32	4.41	3.94
Problem Finding	*M*	6.23	7.90	9.40	9.31	9.79
	SD	3.06	4.35	4.29	4.53	3.59
Product Improvement	*M*	5.90	8.37	8.12	7.87	9.31
	SD	3.38	8.88	3.71	3.72	4.32
Creative Imagination	*M*	4.75	5.54	6.71	5.97	7.50
	SD	2.90	3.17	2.79	3.62	3.55
Problem Solving	*M*	3.66	3.56	4.40	4.88	4.66
	SD	2.07	2.79	2.52	4.57	4.10
Science Experiment	*M*	4.82	5.18	7.65	4.83	9.48
	SD	4.79	4.75	6.17	5.62	8.15
Product Design	*M*	5.47	4.95	6.26	3.85	5.82
	SD	4.40	4.77	5.11	4.62	4.95
Whole Test	*M*	36.94	43.60	52.10	46.23	56.57
	SD	16.45	18.35	16.92	18.17	21.28

In order to explore the age character of scientific creativity of secondary school students, we investigated age difference and significant level of subjects on each task and whole test scores with one-way ANOVA. The result is shown in table 5.

Table 5. The post hoc test of age differences (Tukey HSD)

Item	Unusual Uses					Problem Finding					Product Improvement				
Age	11	12	13	14	15	11	12	13	14	15	11	12	13	14	15
11															
12	*					*					*				
13	*	*				*	*				*				
14	*					*	*				*				
15	*	*				*	*				*				

Table 5 (Continued).

Item	Creative Imagination					Problem Solving					Science Experiment				
Age	11	12	13	14	15	11	12	13	14	15	11	12	13	14	15
11															
12	*														

13	*	*					*				*	*			
14	*					*	*						*		
15	*	*				*					*	*	*	*	

Table 5 (Continued).

Item	Product Design					Whole Test				
Age	11	12	13	14	15	11	12	13	14	15
11										
12						*				
13		*				*	*			
14	*		*			*		*		
15				*		*	*		*	

*p<.05, other cells p >.05

From table 4, table 5, we can conclude that the scientific creativity and its components of adolescents have significant age difference. Although they have an increasing tendency with the increase of age, the scientific creativity and its components do not increase linearly. The detailed trend is as following: Fist, from 11 to 13, creative object applying ability, creative problem finding ability, creative imagination, creative experiment design ability, as well as whole scientific creativity increase rapidly with the increase of age. It is a key stage for the development of scientific creativity of secondary school students; Second, all components except creative problem solving ability drop at 14, but rise again at 15.

The sex difference of scientific creativity of English adolescents

Because sex has significant influence to the creative imagination, creative problem solving ability, creative experiment design ability, creative product design ability, as well as whole scientific creativity of secondary school students, we compared the mean score and standard deviation of subjects in different age on these items and whole test. Their sex differences and significant level also be investigated by t–test. These data are shown in table 6.

Tables 6. Sex differences in components of scientific creativity in the UK sample

6.1 Creative imagination

Age	Sex	*n*	*M*	*SD*	*t*	*p*
11	m	154	4.591	2.963	-1.088	n.s.

	f	101	4.990	2.798		
12	m	149	5.201	2.973	-2.039	<.05
	f	110	6.009	3.380		
13	m	147	6.524	2.950	-1.241	n.s.
	f	101	6.970	2.520		
14	m	121	5.504	3.496	-2.327	<.05
	f	73	6.740	3.723		
15	m	79	7.076	3.478	-1.680	n.s
	f	52	8.135	3.603		
Mean Score	m	650	5.640	3.240	-3.621	<.01
	f	437	6.371	3.297		

6.2 Creative problem solving ability

Age	Sex	*n*	*M*	*SD*	*t*	*p*
11	m	154	3.786	2.390	1.335	n.s.
	f	101	3.465	1.439		
12	m	149	3.644	2.959	.540	n.s.
	f	110	3.455	2.558		
13	m	147	4.714	3.018	2.676	<.01
	f	101	3.951	1.403		
14	m	121	5.041	4.583	.627	n.s.
	f	73	4.616	4.901		
15	m	79	4.987	4.639	1.204	n.s.
	f	52	4.173	3.104		
Mean Score	m	650	4.343	3.497	2.609	<.01
	f	437	3.851	2.705		

6.3 Creative experiment design ability

Age	Sex	*n*	*M*	*SD*	*t*	*p*
11	m	154	4.429	4.532	-1.632	n.s.
	f	101	5.428	5.115		
12	m	149	4.591	4.864	-2.337	<.05
	f	110	5.973	4.479		
13	m	147	6.389	5.504	-3.989	<.001
	f	101	9.475	6.633		
14	m	121	3.703	5.134	-3.713	<.001
	f	73	6.699	5.927		
15	m	79	8.620	7.131	-1.407	n.s.
	f	52	10.789	9.492		
Mean Score	m	650	5.283	5.515	-5.498	<.001
	f	437	7.350	6.247		

6.4 Creative product design ability

Age	Sex	*n*	*M*	*SD*	*t*	*p*
11	m	154	5.149	4.152	-1.632	n.s.
	f	101	5.960	4.741		
12	m	149	4.711	4.656	-.922	n.s.
	f	110	5.264	4.913		
13	m	147	5.619	5.189	-2.414	<.05
	f	101	7.198	4.868		
14	m	121	3.372	4.392	-1.810	n.s.
	f	73	4.603	4.901		
15	m	79	5.658	4.682	-.451	n.s.
	f	52	6.058	5.363		
Mean Score	m	650	4.886	4.681	-3.265	<.001
	f	437	5.856	4.973		

6.5 Scientific creativity: whole test

Age	Sex	*n*	*M*	*SD*	*t*	*p*
11	m	154	36.266	16.794	-.804	n.s.
	f	101	37.960	15.934		
12	m	149	41.718	17.274	-1.933	n.s.
	f	110	46.155	19.505		
13	m	147	50.905	17.312	-1.341	n.s.
	f	101	53.832	16.249		
14	m	121	43.719	17.832	-2.557	<.05
	f	73	50.507	18.043		
15	m	79	55.494	21.458	-.714	n.s.
	f	52	58.212	21.105		
Mean Score	m	650	44.551	18.923	-3.102	<.01
	f	437	48.197	19.113		

The results from table 6 indicated that the scientific creativity of secondary school students has significant sex difference. This difference occurred between 12 to 14 years old. Generally speaking, females' scientific creativity is evidently superior to males'. But as to its components, the males' and females' have different characters. Boy students have higher creative problem solving ability. But girl students have higher creative imagination, creative experiment design ability, and creative product design ability.

The development of scientific creativity of Chinese adolescents

The influences of age, sex, and school to the scientific creativity of Chinese adolescents

In order to explore the influences' main effects and interactions of age, sex, and school to the scientific creativity of adolescents, we employed MANOVA based a 7×2×2 factorial design. The results indicated that λ is .678 (p<.001) to age, λ is .975 (p<.001) to sex, λ is .929 to school (p<.001), λ is .941 (p>.05) to age × sex, λ is .845 to age × school (p<.001), λ is .990 to sex × school (p>.05), and λ is .977 to age×sex×school (p>.05). The main effects of age, sex, school and their interactions on each item score and overall test score are summarized in table 7.

Table 7. Results of MANOVA on effects of age and sex on each item and on the whole test for the Chinese sample (F values)

Source of Variance	Age	Sex	School	Age x Sex	Age x school	Sex x school	Age x sex x school
df	6	1	1	6	6	1	6
Unusual Uses	28.05***	.389	24.49***	2.33*	7.18***	1.84	.169
Problem Finding	11.93***	2.19	46.71***	.560	3.84	9.40**	.811
Product Improvement	23.50***	2.87	5.45*	1.75	.132	.797	.294
Creative Imagination	17.38***	.001	35.03***	.675	2.77*	.679	.234
Problem Solving	17.66***	11.42***	15.30***	1.52	22.42***	.766	.101
Science Experiment	6.86***	3.19	2.85	.377	5.96*	.699	3.20*
Product Design	4.72***	.053	.109	3.37**	19.36***	.122	2.38
Whole Test	36.56***	1.24	53.32***	2.09	15.55***	5.59*	1.81

* p < .05, ** p< .01, *** p < .001

From table 7 we have the following conclusions. First, age has significant main effects on the scores of each item and overall test; second, sex has significant main effects on the scores of overall test and items except Problem Solving; third, school has significant main effects on the scores of overall test as well as items except

Science Experiment and Product Design; fourth, there are significant interactions between age and school on the scores of overall test as well as items except Problem Finding and Product improvement; fifth, there are no interactions between age and sex, sex and school, as well as age, sex, and school on the scores of each item and overall test. The result suggested that age, sex, and school might play an important role in the development of scientific creativity of adolescents.

The age characters of scientific creativity of Chinese adolescents

Because age has significant influence to the scientific creativity of adolescents, we compared the mean score and standard deviation of subjects in different age on each item and whole test. It is shown in table 12.

Table 8. Mean scores and standard deviation for Chinese sample by item and whole test

Age		12	13	14	15	16	17	18
n		76	163	173	164	311	92	108
Unusual	*M*	5.55	5.94	8.10	11.57	12.30	13.17	11.46
Uses	*SD*	4.92	4.07	4.95	5.83	6.65	5.46	5.62
Problem Finding	*M*	5.37	6.55	6.84	8.92	10.90	11.40	10.41
	SD	4.81	4.58	4.63	4.66	5.70	5.71	4.68
Product	*M*	3.50	3.96	4.21	5.37	6.50	6.77	5.63
Improvement	*SD*	2.84	2.09	2.16	2.06	2.86	3.05	2.74
Creative	*M*	2.29	3.77	3.24	4.52	5.79	7.07	5.81
Imagination	*SD*	2.16	2.53	2.09	2.74	3.47	3.31	2.47
Problem Solving	*M*	3.46	7.85	5.96	9.85	11.04	10.80	11.39
	SD	2.65	4.77	2.81	5.81	6.66	6.29	7.64
Science	*M*	1.34	2.68	2.99	3.02	3.90	4.94	5.72
Experiment	*SD*	2.42	3.04	3.45	4.47	5.32	4.71	4.70
Product	*M*	3.72	4.21	3.53	2.87	3.15	1.83	4.28
Design	*SD*	4.56	3.90	3.00	3.51	3.94	3.08	3.81
Test	*M*	25.15	35.06	34.99	46.06	53.75	55.97	54.88
overall	*SD*	15.09	15.58	14.05	15.80	18.13	14.96	16.99

In order to explore the age character of scientific creativity of adolescents, we investigated age difference and significant level of subjects on each task and whole test scores with one-way ANOVA. The result is shown in table 9.

Table 9. The post hoc test of age differences (Tukey HSD)

Item	Age	12	13	14	15	16	17	18
Unusual Uses	12							
	13							
	14	*	*					
	15	*	*	*				
	16	*	*	*				
	17	*	*	*				
	18	*	*	*				
Problem Finding	12							
	13							
	14							
	15	*	*	*				
	16	*	*	*	*			
	17	*	*	*	*			
	18	*	*	*				
Product Improvement	12							
	13							
	14							
	15	*	*	*				
	16	*	*	*	*			
	17	*	*	*	*			
	18	*	*	*		*	*	
Creative Imagination	12							
	13	*						
	14							
	15	*		*				
	16	*	*	*	*			
	17	*	*	*	*	*		
	18	*	*	*	*		*	
Problem Solving	12							
	13	*						
	14	*	*					
	15	*	*	*				
	16	*	*	*				
	17	*	*	*				
	18	*	*	*				
Science Experiment	12							
	13							
	14							
	15							
	16	*						
	17	*	*	*	*			

	18	*	*	*	*	*		
Product Design	12							
	13							
	14							
	15		*					
	16		*					
	17	*	*	*		*		
	18				*		*	
Overall test	12							
	13	*						
	14	*						
	15	*	*	*				
	16	*	*	*	*			
	17	*	*	*	*			
	18	*	*	*	*			

*: p<. 05, other cells: p>.05

From table 8, table 9, we can conclude that the scientific creativity and its components of adolescents have significant age differences. Although they have increasing tendencies with the increase of age, the scientific creativity and its components do not increase linearly. Overall scientific creativity increases from 12 to 13 years old, but stagnate from 13 to 14. It increases again from 14 to 17. The key periods for the rapid development of adolescents' scientific creativity are from 11 to 13 and from 14 to 16 years old. The detailed developing trends of components are as following: Fist, from 12 to 17, creative object applying ability, creative problem finding ability, creative product improvement ability, creative experiment design ability increase rapidly with the increases of age; second, from 12 to 17, creative imagination and creative problem solving ability have increasing tendencies but drop at 14; third, the creative product design ability of Chinese adolescents has a sharp decrease from 13 to 17 followed by some recovery from 17 to 18 years old.

The sex difference of scientific creativity of adolescents

Table 2 indicated that sex has significant influence to creative problem solving ability. So we compared the mean score and standard deviation of subjects in different age on this item. The sex differences and significant levels also be investigated by t –test.

These data are shown in table 10.

Table 10. Sex difference on creative problem solving ability, Chinese sample

Age	Sex	*n*	*M*	*SD*	*t*	*p*
12	m	41	3.90	2.70	1.59	n.s.
	f	35	2.94	2.53		
13	m	95	8.39	4.93	1.71	n.s.
	f	68	7.10	4.47		
14	m	88	6.41	2.96	2.17	<.05
	f	85	5.49	2.58		
15	m	89	9.83	6.26	-.053	n.s.
	f	75	9.88	5.25		
16	m	196	11.76	7.29	2.71	<.05
	f	115	9.83	5.22		
17	m	55	11.26	6.52	.84	n.s.
	f	37	10.14	5.95		
18	m	73	12.89	8.38	3.75	<.001
	f	35	8.26	4.44		
Mean score	m	637	9.83	6.72	5.19	<.001
	f	450	7.97	5.06		

The results from table 10 indicated that Chinese male's scientific creativity is superior to female's. But there is no significant difference between male and female on overall scientific creativity. As to components of scientific creativity, the sex difference on creative problem solving ability is significant.

The school difference of scientific creativity of adolescents

Because school has significant influences to scientific creativity, and exist interactions between age and school, we investigated the school differences and significant levels of Chinese adolescents on each item and overall test at every age stages. The results are shown in table 11.

Table 9: School differences on each item and overall test

Item	Age	School	*n*	*M*	*SD*	*t*	*p*
Unusual Uses	13	ord.	70	5.33	4.12	-2.30	<.05
		key	93	6.90	3.99		
	14	ord.	76	5.28	3.51	-7.96	<.001
		key	97	10.31	4.80		
	15	ord.	62	11.82	6.32	0.44	n.s.
		key	102	11.41	5.54		
	16	ord.	65	10.15	6.98	-2.96	<.01
		key	246	12.87	6.46		

Problem Finding	13	ord.	70	5.03	3.56	-3.82	<.001
		key	93	7.69	4.93		
	14	ord.	76	5.16	2.71	-4.79	<.001
		key	97	8.16	3.35		
	15	ord.	62	8.40	5.06	-1.10	n.s.
		key	102	9.23	4.40		
	16	ord.	65	7.42	4.18	-6.95	<.001
		key	246	11.82	5.70		
Product Improvement	13	ord.	70	3.64	2.04	-1.67	n.s.
		key	93	4.19	2.11		
	14	ord.	76	3.97	1.97	-1.27	n.s.
		key	97	4.39	2.28		
	15	ord.	62	4.95	2.32	-2.06	n.s.
		key	102	4.67	2.97		
	16	ord.	65	6.20	3.51	-0.96	n.s.
		key	246	6.58	2.66		
Creative Imagination	13	ord.	70	2.94	1.99	-3.92	<.001
		key	93	4.39	2.72		
	14	ord.	76	2.61	1.39	-3.87	<.001
		key	97	3.73	2.40		
	15	ord.	62	4.29	2.32	-0.85	n.s.
		key	102	4.67	2.97		
	16	ord.	65	4.03	2.79	-4.77	<.001
		key	246	6.26	3.49		
Problem Solving	13	ord.	70	4.59	2.70	-10.07	<.001
		key	93	10.31	4.52		
	14	ord.	76	5.74	1.91	-0.98	n.s.
		key	97	6.13	3.35		
	15	ord.	62	8.95	5.77	0.75	n.s.
		key	102	8.58	5.47		
	16	ord.	65	7.60	3.55	-4.86	<.001
		key	246	11.95	6.99		
Science Experiment	13	ord.	70	1.06	2.04	-7.04	<.001
		key	93	3.90	3.11		
	14	ord.	76	3.03	3.20	0.13	n.s.
		key	97	2.96	3.65		
	15	ord.	62	3.73	5.12	1.59	n.s.
		key	102	2.59	3.98		
	16	ord.	65	3.31	4.10	-1.21	n.s.
		key	246	4.06	5.59		
Product Design	13	ord.	70	2.39	3.06	-5.84	<.001
		key	93	5.58	3.92		
	14	ord.	76	3.34	2.56	-0.76	n.s.
		key	97	3.68	3.31		

	15	ord.	62	4.36	3.94	4.14	<.001
		key	102	1.97	2.88		
	16	ord.	65	4.29	4.44	2.67	<.01
		key	246	2.84	3.75		
Overall test	13	ord.	70	24.91	10.77	-9.06	<.001
		key	93	42.69	14.26		
	14	ord.	76	29.13	9.28	-5.52	<.001
		key	97	39.58	15.43		
	15	ord.	62	49.29	18.38	1.93	n.s.
		key	102	44.09	13.74		
	16	ord.	65	43.31	18.95	-5.46	<.001
		key	246	56.51	16.90		

We got the following conclusions from table 11. First, the scientific creativity of key middle school students is evidently superior to that of ordinary middle school students at 13, 14, and 16 years old. But this phenomenon does not occur at 15. Second, the creative object applying ability, creative problem finding ability, and creative imagination of key school students are evidently superior to that of ordinary school students, and these items link to divergent thinking. So the results indicated that divergent thinking ability of key school students is significantly higher than that of ordinary school students. Third, there is no significant difference between key school students and ordinary school students on item Product Improvement. The score of key school students are significantly higher than that of ordinary school students at 13 on item Science Experiment, but there are no significantly differences at other ages. This indicated that the technical creativity of key school students is not higher than that of ordinary school students.

The Comparisons of Scientific Creativity between English Adolescents and Chinese Adolescents

In order to explore the difference of scientific creativity between English and Chinese adolescents, we compared the mean score and standard deviation of English and Chinese subjects in different age on each item and whole test. On the basis of that, the differences were investigated by employing t-test. The result is shown in table 18.

Table 12: t values and significances of differences between English and Chinese samples at four ages.

Age:		12	13	14	15
Unusual	*t:*	4.597	9.340	2.919	-2.685
Uses	*p*	<.001	<.001	<.01	<.01
Problem	*t:*	4.118	6.335	5.163	1.820
Finding	*p*	<.001	<.001	<.001	<.05
Product	*t:*	7.593	14.496	11.684	9.610
Improvement	*p*	<.001	<.001	<.001	<.001
Creative	*t:*	10.279	11.052	8.953	7.894
Imagination	*p*	<.001	<.001	<.001	<.001
Problem	*t:*	0.297	-8.484	-2.756	-8.968
Solving	*p*	>.05	>.001	>.01	>.001
Science	*t:*	9.478	10.833	3.822	8.147
Experiment	*p*	<.001	<.001	<.001	<.001
Product	*t:*	2.040	4.605	0.803	5.758
Design	*p*	<.05	<.001	>.05	<.001
Overall	*t*	8.902	10.479	6.667	4.711
test	*p*	<.001	<.001	<.001	<.001

From table 4, table 8 and table 12, we have the following conclusions. (1) There are similar developing trend of scientific creativity between English and Chinese adolescents. The scientific creativity of adolescents has an increasing tendency, but it decrease at fourteen. (2) There are marked differences in scientific creativity between English and Chinese adolescents. Chinese adolescents' creative problem solving ability is evidently superior to that of English adolescents. But English adolescents' other scientific creativity and entire scientific creativity are evidently superior to those of Chinese adolescents. (3) The standard deviations of English adolescents on most items are larger that those of Chinese adolescents. This result indicates polarization of English adolescents on scientific creativity is more obvious than that of Chinese adolescents.

Discussions

The developing trend of adolescents' scientific creativity

Although there is no research about the developing trend of adolescents' scientific creativity, some researchers explored the development of general creativity. The most systematic assessment of creativity in elementary and adolescents has been conducted at the University of Minnesota by Torrance and his associates (Torrance, 1962), who have administered the Minnesota Test of Creative Thinking (MTCT) to several thousands school children. The general pattern of the developmental curve of most of the creative thinking ability is as follows: There is a steady increase from first through third grade. With one exception, there is a sharp decrease between the third and fourth grades followed by some recovery during the fifth and sixth grades. Another drop occurs between the sixth and seventh grades, after which there is growth until near the end of the high school years. From further researches, mostly cross-sectional, Torrance (quoted by Arasteh, 1968) found that people's creativity has four drop or stagnation stages, which are 5, 9, 13, and 17 years old. It was confirmed by other researchers (Dong, 1993, pp. 142). The result of this study is similar to that of Torrance's study. But the drop stage is at 14 years old for scientific creativity of adolescents. This may be linked to science knowledge, because knowledge is the basis of scientific creativity. Elementary school students' science knowledge is very limited. Students of secondary school have more science lessons from the outset. The content is more profound, and the range is more extensive. The increase of science knowledge postpones the decreased time of scientific creativity.

As to the 'drop' phenomena, researchers have different opinions (Dong, 1993, pp. 143). We think it comes from two aspects. First, social pressure and conformity inherent in the tradition have some their root in the phenomena involved in these slumps in scientific creativity of 14 years old adolescents. According to Harry Stack Sullivan's child development theory (quoted by Torrance, 1962, pp. 94), pressures in the transition period toward socialization have almost invariably resulted in a careful sorting out of that which is agreed to by authorities. Strong dependence upon consensual validation develops, and unusual ideas are laughed at, ridiculed, and condemned. The child sees those around him not so much as enemies but as sources of humiliation, anxiety, and punishment with respect to that which they communicate; and this tends to reduce the freedom and enthusiasm of communication, especially of original ideas. Adolescents at 14 years old are in their transition period from experienced logical thinking to theoretical logical thinking. Social pressures and conformity appear. These new demands typically produce feelings of inadequacy and insecurity, as new roles are imposed. The resultant anxiety restricts awareness and produces uncertainty, making creative thinking difficult.

Second, schools and teachers do not attach importance to the cultivation of creativity, especially scientific creativity. This situation lead to that when logical thinking increase as the function of education and the development of mentality, divergent thinking, as a key component of creativity, does not necessarily develop. Education can influenced the development of creativity. This has been confirmed by many researches (Torrance, 1962; Osborn, 1963; De Bono, 1970). A recent meta-analysis was conducted to examine the impact of instructional programs across a wide range of studies. Rose and Lin (quoted by Isaksen & Parnes, 1985) reported that their results suggested that training does affect creativity. They acknowledge that creative thinking is both a skill and an innate ability. The skills can be developed and the innate abilities can be stimulated and nourished through education and training. But teachers prefer more conventional children with high IQ rather than those exhibit creative tendencies (Getzels & Jackson, 1962; Torrance & Hall, 1980). However, researchers (Torrance & Safter, 1986) stated clearly that teachers are ill-equipped to meet the needs of students in terms of creativity. They do not know how to initiate, conduct or evaluate creativity. They also feel uncomfortable with creative students. So present educational situation does not contribute the development of scientific creativity of adolescents. This is an obvious reason of the decrease of students' scientific creativity.

The sex difference of adolescents' scientific creativity

We concluded from this study that English female's scientific creativity is evidently superior to male's in general. But Chinese male's scientific creativity is superior to female's, and the difference is not remarkable. This result may be explained from two aspects. First, Different culture have different sex difference of creativity. The result in this study may be decided by English and Chinese culture. Several researches about the sex difference of students' creativity have been conducted in secondary schools in the past. But different results can be found. Torrance (1962) studied the development of students from grade 1 to adult. The results showed that females' superior to males' in secondary stage. Zhen & Xiao (1983) administered creative thinking exercises to 812 high school students and found that males had higher flexibility scores than females, but there were no other significant sex differences. Shukla & Sharma (1986) studied differences in scientific creativity in 117 males and 113 females in the middle schools of Raipur and Rajnandgaon districts in India. Results indicated that males and females do not differ significantly in any of the measures of scientific creativity. From this study and previous studies, we think culture difference must be considered when discussing the sex difference of creativity. The contradictions of different researches in the sex difference of creativity can be solved according to this interpretation;

Second, this result may be caused by sex difference of academic achievement. In English secondary schools, most female's science achievements are higher than male's. Many researchers think knowledge play an important role in creativity (Amabile, 1983; Alexander, 1992; Sternberg, 1988). In recent years, female's GCSE science scores are higher than male's in English secondary schools, and they are often divided in top and middle band. Solid science knowledge provides the female with the basis for the development of scientific creativity. However, most male's science achievements are higher than female's in Chinese secondary school.

The school difference of Chinese adolescents' scientific creativity

The research indicated that the scientific creativity of key middle school students is evidently superior to that of ordinary middle school students at 13, 14, and 16 years old. This may be interpreted from three aspects. First, the intelligence of key middle school students is higher than that of ordinary middle school students. They also understand science knowledge better. Higher intelligence and solid science knowledge provide them with the basis of development of scientific creativity. Second, the key middle school in this study paid attention to the teaching of science knowledge, offered many selective courses, and trained divergent thinking. Third, teachers in the key middle school took part in teaching research. These promoted the development of divergent thinking. But this phenomenon does not occur at 15. This maybe caused by the entrance examination of senior middle school. Intensive revision before the examination brings higher pressure to key school students than to ordinary school students. This pressure results in the drop of scientific creativity.

The second conclusion from this study is that although divergent thinking ability of key school students is significantly higher than that of ordinary school students, there is no significant difference between key school students and ordinary school students on technical creativity. Because key middle school and ordinary middle school in this study have not offer extracurricular science activities, this lead to that there is no significant difference on technical creativity between the two schools.

From the discussions above, we can conclude school environment is more important on the development of scientific creativity than school type. In this study, key middle school paid attention to the knowledge teaching and divergent thinking training, so the divergent thinking of their students developed quickly. However, they neglected extracurricular science activities, so there is no significant difference on technical creativity between the two schools. In general, psychology only consider the school type when discuss the difference of cognition between different kinds of schools. We think school environment should be discussed when study the difference of cognitive ability between different kinds of schools, so that we can do more profound research and understand this phenomenon better.

The comparisons of scientific creativity between English and Chinese adolescents

Because adolescents have common law and characters of physical and mental development, the developing trend of scientific creativity of adolescents in different cultures are similar. But because scientific creativity is influenced by culture, social environment, family education, school education, etc., it also has different characters in different cultures and education systems. This study indicated that there are marked differences in scientific creativity between English and Chinese adolescents. But English adolescents' other scientific creativity except creative problem solving ability and entire scientific creativity are evidently superior to those of Chinese adolescents. This may be interpreted from following aspects. (1) Culture influences the development of scientific creativity. British culture advocates independent and respects individual character. Individualism is the central value viewpoint of British culture. This is benefit to the development of scientific creativity. But Chinese culture advocates dependents and does not respect individual character. Collectivism is the central value viewpoint of Chinese culture. This prevents the development of scientific creativity. (2) Social environment is another factor influencing the development of scientific creativity. There are more natural museums, science museums, and library in Britain than in China. Secondary school student visit these places very often. They also take part in more science activities than Chinese students. These activities are also benefit to the development of scientific creativity. (3) The parenting style of British family is different from that of Chinese family. Baumrind (1991) divided the parenting style into authority, autocracy, and let things drift. Authority parenting style is benefit the development of creativity, and other parenting styles are not benefit the development of creativity. According to the investigations by Chinese Science and Technology Association (2000), most Chinese families use autocracy and let things drift parenting styles. This prevents the development of scientific creativity. (4) Science teaching also influences the development of scientific creativity. Compared to Chinese science teaching, British science teaching emphasizes inquiry, process, synthesis, and offer many opportunities for students to take part in various science activities. All these are benefit to the development of scientific creativity.

This study also found that Chinese adolescents' creative problem solving ability is evidently superior to that of English adolescents. Two aspects may cause it. First, Chinese students do more science exercises than British students, which can increases problem solving ability. Second, problem-solving item relates to geometric figure, which is a part of mathematics. The mathematics achievement of Chinese adolescents is higher than that of British adolescents. Chinese character is also benefit to the development of space imagination. So the result of this study is reasonable.

Conclusions

(1) The age difference of scientific creativity of adolescents is marked. It has increasing tendency, but decreases at 14. The key periods for the rapid development of adolescents' scientific creativity are from 11 to 13 and from 14 to 16 years old.

(2) The scientific creativity of adolescents has sex difference. English females' scientific creativity is evidently superior to males'. But Chinese males' scientific creativity is superior to females', and the difference is not remarkable. Based on this result and other studies, we proposed the culture model of sex difference of scientific creativity.

(3) There is marked difference in scientific creativity between Chinese and English adolescents. Chinese adolescents' creative problem solving ability is evidently superior to that of English adolescents. But English adolescents' other scientific creativity and whole scientific creativity are evidently superior to that of Chinese adolescents.

(4) There is marked difference in scientific creativity among students in different kind of Chinese schools. Key-middle-school-subjects' scientific creativity is evidently superior to that of ordinary-middle-school-subjects. The authors think school environment and school education are more important than school type to the development of scientific creativity.

References

Albert, R. S. (Ed.). (1983). Genius eminence. New York: Pergamon.

Alexander, P. A. (1992). Domain knowledge: Evolving themes and emerging concerns. Educational Psychology, 27 (1), 33-51.

Amabile, T. M. (1983). The social psychology of creativity : A componential conceptualization. Journal of Personality and Social Psychology, 45, 357-376.

Amabile, T. M. (1987). The motivation to be creative. In S. G. Isaken (Ed.), Frontiers of creativity research: Beyond the basics (pp.223-254). Buffalo, NY: Bearly.

Arasteh, J. D. (1968). Creativity and related process in the young child: a review of the literature. The Journal of Genetic Psychology, 112, 77-108.

Barron, F., & Harrington, D.M. (1981). Creativity, intelligence, and personality. Annual Review of Psychology, 32, 439-476.

Baumrind, D.(1991). The influence of parenting style on adolescent competence and substance use. Journal of Early Adolescents, 11, 56-95.

Chinese Science and Technology Association (2000), The investigation and countermeasure of the cultivation of Chinese adolescents' creativity (pp.25-30). Guangdong Education Press

De Bono, E. (1970). Lateral thinking----a textbook of creativity.London: Ward Lock Educational Limited.

Dong, Q. (1993). The characteristics of children's psychological development in creative ability (Chinese). Zhejiang: Zhejiang Education Press.`

Feldhusen, J. F. (1994). Teaching and testing for creativity. In the International Encyclopedia of Education (2nd ed., pp. 1178-1183). New York: Pergamon Press.

Feldman, D.H. (1986). Nature's gambit. New York: Basic Books.

Findlay, C. S., & Lumsden, C. J. (1988). The creative mind: Toward an evolutionary theory of discovery and innovation. Journal of Social and Biological Structures, 11,3-55.

Gardner, H. (1983). Frames of mind: The theory of multiple intelligence. NewYork: Basic Books.

Getzels, J. W. & Jackson, P. W. (1962). Creativity and intelligence---explorations with gifted students. John Wiiley and Sons.

Hennessey, B. A., & Amabile, T. M. (1988). The conditions of creativity. In R. J. Sternberg (Ed.), The nature of creativity: Contemporary psychological perspectives (pp. 11-42). New York: Cambridge University Press.

Hu, W. & Adey, P. (2002). A scientific creativity test for adolescents. International Journal of Science Education, 24(4), 389-403.

Isaksen, S.G., & Parnes, S. J. (1985). Curriculum planning for creative thinking and problem solving. The Journal of Creative Behavior, 19(1),1-28.

Mumford, M. D., Mobley, M. I., Uhlman, C. E., Reiter- Palmon, R., & Doares, L.M. (1991). Process analytic of creative capacities. Creativity Research Journal, 4, 91-122.

Osborn, A. F. (1963). Applied imagination. New York: Charles Scribner's Sons.

Richardson, A. G., & Crichlow, J. L. (1995). Subject orientation and the creative personality. Educational Research, 37, 71-78.

Runco, M. A.(1999). A longitudinal study of exceptional giftedness and creativity. Creativity Research Journal, 12(2), 161-164.

Shi, J. N. (1995). Cross-cultural study on technical creativity between China and

Germany. Paper presented at the 11th conference of WCGT, Jul. 30-Aug. 4, Hong Kong.
Shi, J. N., Zha, Z. X., & Zhou, L. (1998). A cross- cultural study on the practical creative thinking of supernormal and normal children between China and Germany. In
Zha, Z. X. (Ed.). The Development of Supernormal Children (Chinese). Chongqing: Chongqing Press.
Shukla, J. P. & Sharma, V. P. (1986). Sex differences in scientific creativity. Indian Psychological Review, 30(3), 32-35.
Simonton,D. K.(1983). Formal education, eminence and dogmatism: The curvilinear relationship. Journal of Creative Behavior.
Sternberg, R. J. (1988). A three-facet model of creativity. In R. J. Sternberg (Ed.), The nature of creativity: Contemporary psychological perspectives (pp. 125-147). New York: Cambridge University Press.
Sternberg, R. J. (1996). Successful intelligence. New York: Basic Books.
Taylor, C. W. (1988). Various approaches to and definitions of creativity. In R. J. Sternberg (Ed.), The nature of creativity: Contemporary psychological perspectives (pp. 125-147). New York: Cambridge University Press.
Torrance, E. P. (1962). Guilding creative talent. Prentice- Hall, INC. Englewood Cliffc, N.J.
Torrance, E. P. & Hall, L. R. (1980). ‘Assessing the future reaches of creative potential’. Journal of Creative Behavior, 14(1), 1-19.
Torrance, E. P. & Safter, H. T. (1986). Are children becoming more creative? The Journal of Creative Behavior, 20(1), 1-13.
Treffinger, D. J. (1995). Creative problem solving (C.P.S.): Overview and educational implications. Educational Psychology Review, 7(3), 301-312.
Zhen & Xiao(1983).A study on the creativity of high school students(Chinese). Acta Psychological Sinica, 15(4),445-452.

中英青少年科学创造力发展的比较研究

胡卫平
（山西师范大学课程与教学研究所，山西临汾：041004）
申继亮 林崇德
（北京师范大学发展心理研究所，北京：100875）
Philip Adey
（伦敦大学国王学院，英国）

将中学生科学创造力测验施测于英国 6 所中学的 1190 名青少年及中国 2 所中学的 1087 名青少年的研究，得出如下结论：第一，青少年的科学创造力存在显著的年龄差异。随着年龄的增大，青少年的科学创造力呈持续上升趋势，但在 14 岁时要下降；11-13 岁、14-16 岁是青少年的科学创造力迅速发展的关键时期；第二，青少年的科学创造力存在性别差异。英国女生的科学创造力比男生强，差异显著；中国男生的科学创造力比女生强，差异不显著；第三，中英青少年的科学创造力存在显著的差异。在创造性的问题解决能力方面，中国青少年明显高于英国青少年，但中国青少年在其它方面的科学创造力及总成绩则明显低于英国青少年；第四，中国青少年的科学创造力存在显著的学校类型差异。重点中学学生的科学创造力显著高于普通中学学生的科学创造力。