Measuring creativity: two studies
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Abstract

This writing presents empirical research using the Torrance Test of Creative Thinking to explore the question of creativity and its application within a design curriculum. Two studies were conducted and involved first year college students in design. The first study examined teaching creativity as a topic of learning, even in a curriculum which highly values creativity; the second study examined circadian rhythms, i.e., the variation of creativity at different times during the day.

The Torrance Tests center on the idea that creativity can be measured through generative output, that is, ideas set forth in response to stimuli. Within this writing, the venue and methods of the two studies are presented, along with findings of the research. Design students receiving specific creativity training showed significant increases; a parallel group of students did not. Training can increase the ability to generate ideas, and in addition, both breakfast and time of day may affect the demonstrated level of creativity.

Introduction

Creativity is essential and inherent in humans. And because it is an inherent trait, like strength, it can be developed and improved.

Creativity can also be measured; i.e. the rate at which people generate new, applicable ideas can be quantified and evaluated for divergence, the external and internal differences of their ideas. By extension, we can understand an improvement of our creative abilities.

How we generate new ideas and how those ideas are adapted by society at large is a critical skill in any country or field. The skill is important in all scales of endeavors, from small to large. It is also a skill that can be nurtured, developed, practiced, and taught. It is a challenging mental effort, one which is affected by outside influences, such as the creative environment, nutrition, and the ageless cycles of day and night.

Improving creativity can be accomplished in a number of ways. There are many techniques that encourage one to be creative, but permanent increases in creative ability do not come from a single session or method. As a complex skill it should be considered on a par with writing or research skills. Development of abilities in creativity must be viewed as an ongoing and long term effort, one which must be mindfully addressed.
Much of societal attention is focused on the creative fields such as design, and that is the locus of these two studies. Many educational programs expect creative development to occur naturally within a creative class or studio, and seldom do schools of design teach creativity per se. Other skills such as drawing, writing, or research methods are taught as an expected portion of the curriculum, but specific courses on creativity are less likely. There has been increased recent interest in “thinking skills” courses (such as creativity) in universities, but as yet, these courses have not been widely adopted.

Similarly, little is understood about some other environmental aspects of creativity. Positive and supportive environments are critical to the advancement of creativity in a social context such as academia or business. However, as creativity is a high level cognitive function, other impacts must also be understood. For example, the impact of the time of day on creative ability may be substantial.

This writing begins with a brief review of some aspects of creativity; its definition, relationship to innovation, and applicability. Central to creativity is the generation of new ideas, and that is essential to the use of the Torrance Tests of Creative Thinking. This standardized test allows comparisons with a broad population on a consistent basis. Demographics of the research participants and methods used will be discussed prior to an examination of the results of two studies. Implications include the need for a better understanding of the environmental and personal impacts on creativity.

Creativity and intelligence

There are many popular definitions of creativity, but in general, creativity is the cognitive ability to generate new ideas. It has been defined as "To bring into being or form out of nothing." "The creative process… refers to the sequence of thoughts and actions that leads to novel, adaptive productions" (Lubart, 2001). "Creativity is the generation of new ideas -- either new ways of looking at existing problems, or of seeing new opportunities…” (Cox, 2005, 8).

Innovation, in contrast, is the pragmatic implementation, the fire, from creative sparks. It deals with the adoption and use of different and new ideas. As fire needs air and fuel, so too does the innovation need social support and change (Florida 2002, Rogers, 1991); but the igniting spark is provided by creativity. One can be creative without being innovative; one can have a spark without ignition. Not all ideas catch fire. Cox (2005) writes that "‘Innovation’ is the successful exploitation of new ideas. It is the process that carries them through to new products, new services, new ways of running the business or even new ways of doing business” (8). Here we are specifically interested in creativity more than innovation.

Creativity is inherently tied to general intelligence, but the two aspects of mental capability are not completely correlated. Most in the field of creativity research divide creativity from intelligence and recognize that intelligence does not fully correlate with creativity.
Many studies recognize creativity as a cognitive ability separate from other mental functions and particularly independent from the complex of abilities grouped under the word 'intelligence'. Although intelligence -- the ability to deal with or process large amounts of data -- favors creative potential, it is not synonymous with creativity (Preti & Miotto, 1997, 2).

Creativity, for purposes here, is an applied ability to generate new ideas.

**Teaching creativity**

Efforts to increase creativity are widespread in education and common in industry. While efforts to increase creativity are not limited to training and educational activity, this direction has proved effective in increasing creative output, and is a preferred means (Montouri, 1992).

There are many means to develop creativity in education, including personal, cognitive, motivational, and social interactive approaches (Bull, et. al, 1995). Central to this observation is that creativity is a skill that is inherent in most people, and that training can improve still level. As learners bring different cognitive and social aspects to a given course, a number of different methods should be used. Scott, et. al. (2004) said that "divergent thinking" was common in most training efforts for creativity. Divergent thinking is the development of multiple responses to questions, and the ability to provide numerous applicable answers.

Scott, et. al. (2004) completed a meta-analysis of 70 studies of creativity training. A number of elements differentiated results. Time on task and extensive work were usually needed to develop skills in creativity. Courses that focused on specific structured techniques were usually more effective than courses that merely dealt with open ended creative exercises. The largest gains in measured creativity occurred by the use of these structured techniques, such as convergent thinking (focusing ideas on a given result), critical thinking (thinking about one's thought processes), and the identification of problem constraints.

**The Research Venue**

The research presented here has focused on iterations of a large introductory lecture class on design. Two iterations of the course were used to gather data on creativity from a population of design students. The first iteration dealt with comparisons to creativity training, and the second study varied time of day. Specific instruction in creativity was not included in the large course, but a separate course on creativity was concurrently taken by some of the course participants.

The smaller separate creativity course was a blend of theoretical instruction, application, and rapid idea generation, and was taught by the author. The nature of the course was
consistent with recommendations inherent in Fasko (2001), and the findings in Scott, et. al. (2004). Data from nine students is included in this study.

**Measuring creativity**

With current advances in brain imaging, there are ways to directly observe creative activity in the brain, but most research focuses on psychometric methods of "direct measurement of creativity and/or its perceived correlates in individuals" (Plucker & Renzulli, 2002, 35). Guilford and Torrance, leading early researchers in the field of creativity, viewed idea diversification as a focus for creativity and developed psychometric measures of this kind for assessment.

We have discussed that creativity can be recognized as the ability to generate a wide number of ideas addressing a given problem or stimulus. This implies the ability to develop different *types* of ideas for any given instance, as well as the ability to generate *unexpected* ideas. These three areas are the main aspects of standardized tests of creativity developed by Dr. Paul Torrance, and are categorized as fluency, flexibility, and originality.

The Torrance Tests of Creative Thinking (1974a) are the most broadly used standardized measurement tool of creativity: "...by far the most commonly used test of divergent thinking and [which] continues to enjoy widespread international use" (Plucker & Renzulli, 1999, 39).

There are, of course, limitations to any method of testing, but the TTCT does provide a good understanding of some aspects of creative abilities. It is a pragmatic method of testing, and the results can be scored by the researcher or the publisher; and the history of the test provides a substantial data base of previous test results for comparison.

**Elements of the Torrance Tests of Creative Thinking**

The Torrance Tests of Creative Thinking (TTCT) are available in two forms, visual and written, and the written form may be completed in English or Spanish. The English written version was used in this research. There are six sections in the test that ask for multiple written responses to illustrations and verbal prompts. Each section is timed, with responses measured over five or ten minutes. There are two versions of the test, labeled A and B, which are designed to complement each other and be used interchangeably. They also may be used together for a pre- and post- treatment measurement.

**Fluency** is the first metric. It addresses the understanding that creative people generate more ideas for any given question. The tests pose a hypothetical situation and ask for responses. Participants are evaluated by the number of answers given. For example, if question asked what one could eat, responses could include, for example, pizza, bread, or fish. Providing more answers would be indicative of a higher level of creativity.
Participants are informed that they will be evaluated on the number of answers they provide.

How an individual's answers vary among themselves is evaluated in the metric called **Flexibility**. Creativity is seen to seek answers that go beyond slight differences and to generate new answers different from those previously given. For example, when asked what they could eat, participants could respond with food from a different culture or something not normally considered food items, but minor changes in a specific item would not count. One could eat pizza with onions or pizza with chicken; both, however, are variations of the same food type.

**Originality** looks at answers against a common list of responses to the same problem. In our example, "pizza" is an answer that could be a response around the world, but eating one's hat or eating one's words would be less expected responses in almost any culture. The answers that are sought are those that are unexpected, novel, and new; by definition, creative answers.

**The Training Study**

The Torrance Test was administered to the large Introduction to Design lecture class as well as the embedded creative problem solving class. Nine students from the smaller class were included. The large lecture class was required of all new design students at the university and is also open to other students at large. It consists of a series of lectures, presentations, and readings about design. While all design students take introductory studios in their major of interior, graphic, or clothing design, this may be the only design-oriented class for non-design majors. For this study, only design students were used.

The TTCT was administered two times for a pre- and post-treatment evaluation, separated by about 14 weeks over the course of fall semester. 95 students took both versions of the TTCT, but only 53 first year students were scored for this study, selected because they were majoring in design. 46 of the participants were female, and 7 were male, a gender breakdown that is generally consistent with design students registered at the university. Along with this group were the nine students who were enrolled in the creative problem solving course.

Tests were scored by Scholastic Testing Services, publisher of the Torrance Tests.

**Results**

Those students in the creative problem solving course, i.e., those that had received extensive training in creativity, demonstrated significant (at 0.05) gains in measured creativity in all areas tested. Fluency increased by 34.4%, flexibility increased by 35.3%, and originality increased by 55.2%. See Table 1 for further information.
Table 1: Fluency scores and comparisons; effect size

<table>
<thead>
<tr>
<th>Group</th>
<th>Fluency RS – A mean</th>
<th>Fluency RS – B mean</th>
<th>Difference</th>
<th>t-test A:B</th>
</tr>
</thead>
<tbody>
<tr>
<td>Treatment 2005</td>
<td>94.67</td>
<td>125.44</td>
<td>134.41%</td>
<td>0.00047*</td>
</tr>
<tr>
<td>[n = 9]</td>
<td>[26.81]</td>
<td>[33.73]</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Control 2005</td>
<td>88.40</td>
<td>90.56</td>
<td>102.45%</td>
<td>0.49</td>
</tr>
<tr>
<td>[n = 51]</td>
<td>[27.08]</td>
<td>[33.04]</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Treatment v.</td>
<td>0.42</td>
<td>0.0020*</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Control t-test</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Glass' Delta</td>
<td></td>
<td>1.056</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Treatment</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Glass' Delta Control</td>
<td></td>
<td>0.065</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

RS = raw score. SD = standard deviation. * = significant at .05

The students in the larger group, acting a control to the creative problem solving course, did not show comparable gains over the course of the term in any of the three metrics. The fluency score for students in the control group increased by 2.5%, an insignificant change. The score for flexibility increased by 2.9%, and this change was also not significant. See Table 2 for further information.

Table 2: Frequency scores and comparisons; effect size

<table>
<thead>
<tr>
<th>Group</th>
<th>Flexibility RS – A mean</th>
<th>Flexibility RS – B mean</th>
<th>Difference</th>
<th>t-test A:B</th>
</tr>
</thead>
<tbody>
<tr>
<td>Treatment 2005</td>
<td>48.33</td>
<td>63.89</td>
<td>135.27%</td>
<td>0.000073*</td>
</tr>
<tr>
<td>[n = 9]</td>
<td>[10.84]</td>
<td>[10.29]</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Control 2005</td>
<td>49.40</td>
<td>50.84</td>
<td>102.92%</td>
<td>0.36</td>
</tr>
<tr>
<td>[n = 51]</td>
<td>[11.16]</td>
<td>[12.77]</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Treatment v.</td>
<td>0.61</td>
<td>0.0013*</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Control t-test</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Glass' Delta</td>
<td></td>
<td>1.022</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Treatment</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Glass' Delta Control</td>
<td></td>
<td>0.056</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

RS = raw score. SD = standard deviation. * = significant at .05

Originality (the generation of ideas that are new and uncommon in society at large), increased by 16.3%, and this was statistically significant. See Table 3 for further information.
Table 3: Originality scores and comparisons; effect size

<table>
<thead>
<tr>
<th>Group</th>
<th>Originality RS – A mean</th>
<th>Originality RS – B mean</th>
<th>Difference</th>
<th>t-test A:B</th>
</tr>
</thead>
<tbody>
<tr>
<td>Treatment 2005</td>
<td>66.00</td>
<td>98.56</td>
<td>155.20%</td>
<td>0.00052*</td>
</tr>
<tr>
<td>[n = 9]</td>
<td>[23.41]</td>
<td>[31.87]</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Control 2005</td>
<td>59.19</td>
<td>66.16</td>
<td>116.35%</td>
<td>0.017*</td>
</tr>
<tr>
<td>[n = 51]</td>
<td>[22.73]</td>
<td>[26.60]</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Treatment v. Control t-test</td>
<td>0.80</td>
<td>0.0020*</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Glass' Delta</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Treatment</td>
<td></td>
<td>1.218</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Glass' Delta Control</td>
<td></td>
<td>0.262</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

RS = raw score. SD = standard deviation. * = significant at .05

The results found were consistent with the meta-analysis of creativity training programs examined in Scott, et. al (2004). There, 70 studies of creativity training and testing were evaluated, and the effect size was calculated by the Glass' Delta method (calculated by the mean difference between the experimental and control group divided by the standard deviation of the control group). They list a mean effect size of .70 for all combined instructional methodologies and a mean of .75 for divergent thinking methods with a standard deviation of .67. The effect size for this class was calculated at 1.06 for Fluidity, which is higher than but comparable to the mean. It is approximately .42SD above the mean, well within an expected distribution of results. Glass's Delta as calculated for Originality for the treatment group was 1.21. For the control group it was .262. This appears to indicate that about 25% of the increase in Originality was due to the common activities of the larger class.

The treatment group was compared to the control group for both the A and the B versions of the test. While there was no significant difference prior to treatment, there was a significant difference after treatment, in spite of significant gains by the control group.

Discussion

This study involved research using the Torrance Test of Creative Thinking verbal version. It involved design students at an American university in their first year of a four-year program of study in design. Significant differences were found between the treatment and the control groups; treatment being training in a separate course in creative problem solving.

Measured creativity increased in the group that received training; the other group demonstrated changes in one area of testing over the same interval, but at a much lower level than those students receiving training.
This study focused on new design students. Whether or not this observation can be extended to students in other fields is speculative; however, as the tests did not directly address specific domain issues, this may indicate such training could be effective in other fields. As this study focused on entering or first year design students, it would be valuable to understand more about the development of creativity over the full span of a college education, and whether or not the benefits of creativity training are retained.

A side order: Breakfast

Prior to testing, it was hypothesized that other factors, such as gender, dominant-handedness, or nutritional habits could also have an effect on cognitive performance as evidenced by the Torrance Tests. Research has indicated that cognitive levels are influenced by nutrition, and possibly also as to types of nutritional input. Participants in the testing were asked whether or not they had had breakfast prior to testing which began at 9:30 a.m.

Of the 53 participants, 29 said they had eaten breakfast and 24 said they had not eaten breakfast. Breakfast was defined for the research, and as presented to the research subjects, as being "something more than a cup of coffee." No surveys were done to record food intake. On all three measures, those students eating breakfast scored significantly higher than those who did not. This would also be valuable for additional study in the future.

A preliminary study of circadian rhythms and creativity

The following is a report of a preliminary study of the influence of time of day on creativity. Again, the Torrance test of Creative Thinking was used as a standard measurement tool.

Circadian rhythms are the daily biological changes in our abilities throughout the 24 hour day. Most people are very familiar with larger seasonal changes affected by changes in available daylight; seasonal affective disorder is commonly experienced by residents of high latitudes. Another concept within the range of studies of circadian rhythms is the concept of jet lag, the disruption of sleep and waking cycles due to long distance air travel east or west.

Humans, like most animals, have biological rhythms that correspond to a regular daily schedule. The most evident function is the sleep-wake cycle, but through the course of the day body temperature, heart rate, metabolism, receptiveness to certain medicines, and cognitive function all vary.

Body temperature variation was first observed in test subjects isolated from daylight cycles in a cave by Kleitman (1939). Body temperature, which he held was connected with cognitive ability, reached a low point about 6 a.m. and peaked in early evening.
Kreitzman (1963) showed that cognitive capability generally was at its lowest on waking in the morning, using tests of dexterity, mathematics, and drawing to evaluate mental skills over a normal awake cycle. Performance generally peaked at noon or shortly thereafter, declining gradually, with some variation until late evening.

"…rhythms include our body temperature, which is higher during the day than at night, as is our heart beat and blood pressure; we have a clear sleep/wake cycle; our cognitive ability change rhythmically over a 24-hour period. Tooth pain is lowest after lunch; proof reading and sprint swimming are best performed in the evening; labour pains more often begin at night and most natural births occur in the early hours; sudden cardiac death is more likely in the morning" (Foster & Kreitzman, 1005, 11).

This has been supported by Colquohoun (1972) and others finding a daily rhythm of mental ability. While Klietman felt that such changes were caused by the variation in body temperature, Colquohoun felt that the body temperature changes paralleled changes in ability (Folkard, 1990).

Folkhard holds that mental ability is dependent on a range of variables including circadian time; it also is affected by waking hours (time awake) and type of task. Some tasks, such as those involving short term memory are significantly better performed in the morning, while some tasks, such as editing are better undertaken in the early evening (Folkard, 1990). Creativity, as a relatively complex mental task, would be expected to follow the general curve of abilities of body temperature, and should be more evident later in the day.

In addition to variance of time, the age of the study participants was also a matter of interest. Younger adults have a later and less defined circadian cycle than mature adults, with an expected difference of 2-4 hours. This could mean that early morning testing, involving challenging mental tasks, would result in lower scoring than comparable testing of mature adults. (In response to this, many schools districts in the United States, have pragmatically changed start times for high school students (aged 14-18) to one or two hours later in the day than elementary students.)

Method and venue

Within a large lecture class 142 undergraduate students completed the B section of the Torrance Test of Creativity at the regularly scheduled class time of 9:30a.m. Approximately eight weeks later volunteers were solicited through the use of course extra credit to again complete the TTCT, but in the afternoon. 57 volunteers completed the test on one of two days; the test was offered at 4 p.m. 56 of 57 participants had taken the previous application of the test in the classroom setting and were scored for this study. The A version was used for this testing.

(The written Torrance Tests come in two parts, A and B. According to Scholastic Testing, the publisher of the tests, the tests may be administered in any order. While the raw scores were used to evaluate performance on this test, due to variations in the tests,
standardized scores provided by Scholastic Testing Services were used as well to examine changes in measured creativity.

Age of the participants ranged from 19 to 29. One participant was 29, the remainder 24 or below. The average age of participants was 19.6. This is important as the circadian clocks of young adults differ from more mature, e.g. 30-year-old adults. This may mean that the demonstrated change in mental capability as expressed through creativity testing would be more significant, or not. These changes could also be tested on more mature adults as well.

Participants were asked to rate themselves as being a "day" or "night" person to provide some understanding of their personal observations. About half of the participants described themselves as "night" persons. Those that were not self-categorized were assigned as "day" persons.

Prior to testing, it was anticipated that retesting of the participants would demonstrate gains in creative output. Note that earlier repeated measures with a comparable population did not indicate significant improvement or gain when testing occurred at the same time of day. (e.g. 9:30 a.m. to 9:30 a.m.).

Test scores in all areas indicated significant differences in performance. See table 3.1. While there was some variance in each of the areas of testing, the strength of the change in each area was substantial. The mean for Fluency increased by 55.34% and this was significant at .05. All but three participants in the testing increased their raw score, i.e. increased the number of their answers provided. Standardized scores, a distillation of raw scores in comparison with the broader society, increased by 19.64. As the mean for TTCT standardized scores is 100 and the standard deviation is 10, this was not greater than 2 standard deviations and may not be significant.

The mean for Flexibility increased by 52.79% and was significant. The standardized score increased by 31.75 and is also significant. All participants but one increased their raw score. The mean for Originality increased by 77.77%. The standardized score increased by 24.92 and is also significant. See table 4 for more information.

**Table 4: Time of day scores and comparisons**

<table>
<thead>
<tr>
<th>Group</th>
<th>[n=50]</th>
<th>RS B mean</th>
<th>RS A mean</th>
<th>Percent A/B</th>
<th>t-test B:A</th>
<th>SS - B mean</th>
<th>SS - A mean</th>
<th>Diff in SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fluency</td>
<td></td>
<td>73.94</td>
<td>114.86</td>
<td>155.34%</td>
<td>0.000*</td>
<td>102.57</td>
<td>122.20</td>
<td>19.63</td>
</tr>
<tr>
<td></td>
<td>[SD]</td>
<td>[21.34]</td>
<td>[28.64]</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Flexibility</td>
<td>[SD]</td>
<td>39.90</td>
<td>60.96</td>
<td>152.79%</td>
<td>0.000*</td>
<td>99.61</td>
<td>131.14</td>
<td>31.75*</td>
</tr>
<tr>
<td></td>
<td>[8.17]</td>
<td>[10.74]</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Originality</td>
<td>[SD]</td>
<td>44.98</td>
<td>79.96</td>
<td>177.77%</td>
<td>0.000*</td>
<td>102.10</td>
<td>127.02</td>
<td>24.92*</td>
</tr>
<tr>
<td></td>
<td>[19.21]</td>
<td>[23.91]</td>
<td></td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>

RS = raw score. SS = Standardized score SD = standard deviation.  
* = significant at .05
Discussion

This seems to indicate that time of day is an important consideration in addressing the cognitively difficult task of creativity. This may mean that individuals should recognize this possible orientation, and take it into account when addressing creative activities. This does not reflect or examine possible mid- to late-afternoon decreases in cognitive ability, interpersonal declines in cognitive function at other times of the day, or variance among groups.

The experiment will be repeated with additional volunteers in the near future. Test subjects will complete the two versions of the TTCT. They will be randomly assigned to different times for their initial testing. It had been hypothesized that the research subjects, self-selected for the follow-up testing in the current study, had all experienced the test, and were basing their participation on previous positive experience.

It does seem to indicate that the cognitive function of creativity is a challenging mental task, and one which cannot be viewed as available in equal measure every hour of the day. The mental effort of creativity needs to be treated as a sensitive aspect of the human mind, and specifically addressed with the resources of time and nutrition.

Clearly this supports the idea that tests involving biologically related activities, including cognitive and creative ones, should address the time of day when tests were administered. [This could have significant impact on other forms of standardized testing including the Scholastic Aptitude Tests, the Graduate Record Examination. Students taking these examinations at a standardized time may be less successful than if they completed the exams at a time best suited to their own circadian rhythms.]

This and other research may also affect class and curricular scheduling of courses in creativity, design, and throughout the university.

Individual variation may also play a significant role. Students were queried about their self-description as a "night" or "day" person; these coarse measures of personal performance may be accurate, and/or not detailed for significant improvement. Similarly, the complexity and effort of any task affect the abilities of a person during the day; e.g. short term memory peaks during the early morning may mean that didactic class sessions work well in the morning, which is consistent with many college lecture classes, and analytical tasks are better performed later in the day or early evening, which may indicate that those times are more applicable for active learning. At the least, student performance could be improved by lecturing in the morning and testing in the afternoon.

This may also be a strong argument for online asynchronous learning. Students and faculty could both adjust their schedules to be more effective in their activities, as opposed to now, with wide-awake faculty and bleary-eyed students.
Conclusion

There are some simple conclusions from the research. First, training can be effective increasing the measured creativity as with other cognitive skills. (For example, people who take classes in Spanish, when tested, find their knowledge of Spanish increases.) Second, both nutrition and circadian rhythms can have significant and strong effects on measured creativity, which is consistent with other mental abilities.

Measuring the capability of creative people is not well understood; we still view them as a small holy class, usually not examining the basis of their magic. If we view creativity as something performed by a small, holy class, we will not examine how to make others perform that same magic. Perhaps creativity is magic, but through these investigations we can better learn and understand and improve.
Bibliography
Scholastic Testing Services.