Enhancing the measurement of remote associative ability: A new approach to designing the Chinese Remote Associates Test

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**Abstract**
The Remote Associates Test (RAT) is an important measurement of creativity and is well known because it is simple to use and the results are objective. To determine how the RAT would work for native Mandarin speakers, RAT was translated into Chinese in 2004 in a version called the CRAT. However, the construct validity of the CRAT was absent, and correlations with other creativity tasks, such as the Divergent Thinking Test and Creative Tendency Inventory, were not significant. Thus, the validity of the CRAT is limited. To enhance the CRAT, based on the remote association of the Association theory, the present study initiates a new approach to redesign the CRAT by developing a set of remote associate items with low frequency vocabularies and a set of close associate items with high frequency vocabularies, according to the associative hierarchies. By investigating the performance of 49 participants on these remote and close associate items, we determine the passing rate, response time, and the correlations with the Divergent Thinking Test and the insight problems task as well as the validity of the CRAT in the measurement of creativity. We find that the passing rate of remote associate items was lower than that of the close associate items as it took more time to solve remote associate items than close ones. The remote associate items were positively correlated to the Divergent Thinking Test and the insight problems task, but the close associate items were not related to these tasks. The passing rates of remote associate items and close associate items were higher in high creativity groups than low creativity groups. The construct of the present CRAT is strongly correlated with creativity and is now effective for measuring the creativity of Mandarin language speakers.

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1. Introduction
Creativity is a high-level cognitive ability and is exclusive to human beings. Research approaches and knowledge backgrounds have diversely defined creativity (Sternberg & Lubart, 1999). In particular, the Association theory defines creativity as an ability to re-unite irrelevant and independent elements into a new creation for specific needs or purposes (Mednick, 1962); by this definition, the remote associates test was developed to measure creativity (Mednick & Mednick, 1967). The
remote associates test is easy to use and provides objective results; it has been widely applied in creativity research (Cerruti & Schlaug, 2009; Isen, Labroo, & Durlach, 2004; Sio, Monaghan, & Ormerod, 2013; Storm, Angello, & Bjork, 2011; Ward, Thompson-Lake, Ely, & Kaminski, 2008; Zhong, Dijksterhuis, & Galinsky, 2008).

In creativity measurement for Mandarin speakers, Jen, Chen, Lien, and Cho (2004) translated and edited the remote associates test into the Chinese Remote Associates Test (CRAT). CRAT has been published for ten years but it does not have a significantly positive correlation with other creativity performance measurements, such as the Divergent Thinking Test (Huang, Chen, & Liu, 2012; Jen et al., 2004), and thus cannot determine creativity. Moreover, we have no idea if the response process does indeed require the ability of remote association, as the theory itself describes. The design of the CRAT was possibly influenced by the aforementioned conditions because it mixed high and low frequency stimuli within a single item; consequently, it is unable to attribute the response to remote or close associations. Responses to high frequency stimuli were not the product of creation (Gupta, Jang, Mednick, & Huber, 2012). Performance on the CRAT could not be guaranteed to result from creativity when high frequency and low frequency stimuli are combined together in one item; the result is confounded by the creative and non-creative responses. Hence, the present study proposes a new approach to enhance the CRAT with a set of low frequency items that might improve the validity. To address this issue, the present study aims to design the remote and close associate items in Chinese according to the frequencies of stimuli characters. Additionally, by comparing the performances with remote and close associate items, and the correlation with other creativity tasks, we will understand the efficiency of measuring creativity with the CRAT.

1.1. Remote association and associative hierarchy

The performance of remote association is defined as a kind of creativity, or an ability that individuals possess to connect seemingly unrelated elements into a new creation that satisfies some specific needs or goals (Mednick, 1962). An individual’s creativity depends on how distant two concepts connect. By definition, a remote association concept means the knowledge nodes that are distant from and less relevant to topics in a semantic network are connected; conversely, a close association concept means the nodes that are close and highly related to topics are connected (Collins & Loftus, 1975). Mednick used the idea of “associative hierarchy” to describe why the results of free association could be a measurement of creativity. Additionally, he indicated that individuals with higher creativity usually used a flat associative hierarchy to link more concepts, and consequentially thought of the remote concepts, which was remote association; conversely, individuals with lower creativity usually used a steep associative hierarchy, so the results of association were limited to the concepts of strongly related to the topics, which was a close association. Empirical studies found the semantic network free associated by creative people was more flexible, but the network associated by less creative people was relatively rigid (Kenett, Anaki, & Faust, 2014; Kenett, Beaty, Silvia, Anaki, & Faust, 2016), which shows that people with higher creativity are capable of disregarding the restriction of rules and thus develop novel ideas.

Three hypotheses were proposed for the associative process of different associative hierarchies (Ward, 1969), the order effect, the probability effect, and the strength effect, and these hypotheses have been supported by empirical data (Coney & Serna, 1995; Friedman, Fishbach, Forster, & Werth, 2003; Gough, 1976; Gruszka & Necka, 2002; Lin, Lien, & Jen, 2005; Milgram & Rabkin, 1980). First, the order effect suggested that all people started associating from close concepts and extended to remote concepts, and associating remote concepts took more time than associating close concepts (Gruszka & Necka, 2002). Second, the probability effect posited that individuals with higher creativity had more possibilities to associate the remote concepts than those with lower creativity, and associating the remote concepts was more difficult than associating the close ones for individuals, thus the possibility of linking the remote concepts was lower than that of linking the close concepts (Rossmann & Fink, 2010). Lastly, the strength effect proposed that for individuals with higher creativity, it was less possible to connect the close concepts than for those with lower creativity, but they had a stronger association with remote concepts. Thus, the strength effect indicates that associating the close concepts and the remote concepts was quite different between individuals with higher creativity and those with lower creativity. The creative individuals could associate the close concepts and gradually connect them to more remote concepts, whereas the those with less creativity would only develop more close concepts instead of more remote concepts. However, as empirical data showed, the more creative group had better performance in remote association as well as close association than the less creative group (Benedek & Neubauer, 2013; Lin et al., 2005), which indicates inconsistent results for the strength effect hypothesis. In summary, remote concept associating takes longer and is more difficult; also, individuals with higher creativity have different patterns of development for associating remote concepts and close concepts.

1.2. The development and limitations of the Chinese Remote Associates Test

The associates test was an inventory developed by Mednick and Mednick (1967) and Mednick (1968) based on his Association theory. It contained common language material, and every item was composed of three words that served as the stimuli for comparison of remote concepts. The task was to find a word that could combine with each of the three stimuli to give three actual nouns. For instance, if the stimuli items were blood, music, and cheese, an answer could be blue, which combined with the stimuli gives blue blood, blue music, and blue cheese. The original remote associates test contained 30 items, each of one credit, and incorrect responses did not count. The performance of remote association was calculated as the correct answers ratio ( \( \frac{\text{the correct answers}}{\text{total items}} \) ).
The Chinese version of the RAT was first designed using the method of “character-pairing” by Jen et al. (2004). Just as with the RAT, every item of the CRAT contained three stimuli. For instance, if the characters “生” (to generate), “天” (sky), and “温” (warm) were given, the task was to find a target character that could combine with each of the three stimuli to give three actual nouns (the target nouns), with each noun composed of two Chinese characters. The target character (or answer) of this item was “氣” (air), with the combined answer and stimuli forming the three actual nouns “生气” (anger), “天气” (weather) and “气温” (temperature). The stimuli were sampled from the “Mandarin Dictionary Word Frequency Statistics Reports” (Ministry of Education, Taiwan, Taipei, 1998). For the design of all items used in the CRAT, Jen et al. controlled the frequencies of target nouns and the positions of stimuli in the target nouns for each item so that researchers could balance the types of all items and develop the items at every level of difficulty (Chen & Wu, 2014).

However, finding target nouns with high frequencies was not definitively a performance of creativity. Gupta et al. (2012) claimed that having too much experience with the high frequency stimuli would inhibit creativity during the tasks. Despite the control of frequencies of target nouns (Jen et al., 2004), the results of the CRAT still failed to present an individual’s creativity; mixing the items with high frequency confounded the results of the CRAT and was therefore the potential reason why the CRAT scores and the performance in other creative tasks were not significantly related.

Moreover, the development of the CRAT (Jen et al., 2004) started from the target noun and then chose the stimuli that were relative remote concepts to the target noun (Jen et al., 2004). Taking Fig. 1 as an example, in Fig. 1(a), the stimuli were “天” (sky), “温” (warm), and “生” (to generate), the target character was “気” (air); the three stimuli were chosen from the remote concepts in the associative hierarchy of “気” (air). During the task, participants started to associate from the stimuli and the performance of remote association would only be identified when participants thought of the concepts; these concepts were relatively remote from the stimuli and were linkable to all the stimuli in the item (Mednick, 1962; Martindale, 1981, 1995). In other words, researchers should examine the associative hierarchies of the stimuli and confirm that all combinations of stimulus and target character were also qualified to be remote concepts in the associative hierarchies of the stimuli. The associative hierarchies of “天” (sky), “温” (warm), and “生” (to generate) are illustrated in Fig. 1(b)–(d), and one can see that one of the combinations of stimulus and target character is not the remote concept in its associative hierarchy. To develop the content of the items, the rule of remote concept shall be applied to every pair of stimulus and target character. If any stimulus in an item was not a remote concept, the participant would determine the answer without using remote association, and thus that stimulus was not qualified for remote association but only qualified to be a close associate item. This issue with associative hierarchies was another possible reason that the CRAT and other creativity tasks were only slightly relevant.
1.3. The relationships between remote association, insight, and divergent thinking

With respect to the structure of question types (Wakefield, 1992), the remote associates test and the insight problems task are open-ended questions but with closed-ended answers (Chiu, 2005; Chiu et al., 2008); the divergent thinking test is composed of closed-ended questions with open-ended answers (Hsu, Chen, & Chiu, 2012; Torrance, 1974; Wu et al., 1998). Their structures are quite different. Additionally, many researchers claimed the processes of remote association and insight problems were alike (Bowden & Jung-Beeman, 2003a; Chen, Peng, & Wu, 2011; Lubart, 1994); the results of empirical research supported the positive correlation between the performance of the remote associates test and the scores of the insight problems task (Huang et al., 2012). Although the divergent thinking test and the remote associates test are different in structure, the remote associates test is a kind of free-thinking process with thinking of remote concepts (Mednick, 1962). During remote association, individuals would begin by using some of the stimuli to link all possible words, and then pair possibilities with the other two stimuli to determine the correct answer (Smith, Huber, & Vul, 2013). In particular, remote association and fluency of divergent thinking are similar because both ideas emphasize the amount of the concepts developed, and the remote concepts and originality are about unique and rare ideas. Henceforth, the presentation of the remote associates test shall be positively related to the scores of fluency and originality of the divergent thinking test. To sum up, we propose that individuals solved the remote associates test by way of fluent free thinking and consequently reached the remote concept with originality when the insight process occurred simultaneously. Hence, our test measures not only the ability of insight problem-solving but also the ability of divergent thinking.

1.4. The present study

The remote associates test is time-economical, the scoring is objective and convenient, and it is effective in assessing the potential for creativity. In addition, the development of the remote associates test is relatively easy, which is advantageous for enlarging the scale of the items and to decrease the problem of practice effect; thus, the remote associates test is widely used in creativity research (Cerruti & Schlaug, 2009; Storm et al., 2011; Ward et al., 2008; Zhong et al., 2008). We have a Chinese Remote Associates Test (Jen et al., 2004) and it has been widely used to measure creativity among many Chinese people (Chiu & Yau, 2010). However, it is rare to find a positive correlation with other creativity tasks, so the criterion-related validity remains absent. Additionally, the version of the CRAT in use does not design the items with associative hierarchy of stimulus. To address this issue, the present study aims to use a new approach to enhance the CRAT by the theory of associative hierarchies (Mednick, 1962) and to avoid confounding high frequency items in the measurement of creativity (Gupta et al., 2012). Instead of using the previous design, for the CRAT in the present study, we choose stimuli which are remote concepts with low frequency in the associative hierarchies around the stimulus characters so that the effectiveness of the CRAT will be improved for measuring creativity, and it will be a practical tool for measuring the remote association ability for Chinese people.

To verify how well the CRAT of the present study evaluates the ability of remote association, we designed a remote associates test as well as a close associates test composed of high-frequency words. For comparison of passing rates, response times of accuracy, and the correlations to insight problem-solving and to divergent thinking tests, we also examined the performance of remote associate items with Association theory (Mednick, 1962).

We concluded that remote association is characterized by the following: (1) remote association takes more time than close association (Gruszka & Necka, 2002); (2) individuals think of close concepts more often than remote concepts (Rossmann & Fink, 2010); and (3) individuals with higher creativity think of more remote concepts than individuals with lower creativity (Benedek & Neubauer, 2013; Lin et al., 2005; Martindale, 1981, 1995). In addition, the performance of the remote associates test reflects the ability of insight problem-solving (Bowden & Jung-Beeman, 2003; Huang et al., 2012) and is also a kind of presentation of the fluency and originality of divergent thinking (Torrance, 1974).

The hypotheses of the present study are: (1) it takes more time to solve remote associate items than close associate items; (2) the passing rate of remote associate items is lower than that of close associate items; (3) the high creativity group has a higher passing rate of remote associate items than the low creativity group; and (4) the passing rate of remote associate items is positively correlated to each index of insight problems task and each index of divergent thinking, but the passing rate of close associate items is not related to either the insight problems or divergent thinking. We aim to establish a new approach to develop the CRAT by way of comparing the differences between the performances of remote associate items and close associate items. By correlating the performances to other classic creativity tasks, we can measure creativity more effectively.

2. Methods

2.1. Participants

The participants were 49 voluntary undergraduates. Specifically, 23 males and 26 females from 19 to 29 years old (\(\text{Mean} = 23.20, \text{SD} = 2.73\)). All the participants are native Chinese speakers and right-handed with normal eyesight after optometric correcting. The procedure of the present study is verified by and consistent with the rules of the Institutional Review Board (IRB) of the Research Ethics Office of the National Taiwan University, Taiwan. All participants agreed to pro-
ceed with the research after being well informed and completing the informed consent form. Participants received a test fee, NTD.150, as compensation after the experiment was completed.

2.2. Measures

2.2.1. The Remote and Close Associate Items

The material of the “Remote and Close Associate Items” were sourced from the “Mandarin Dictionary Word Frequency Statistics Reports” (Ministry of Education, Taiwan, Taipei, 1998). These reports collected 31,422 two-character expressions; the total use frequency was 409,753 times, and the scopes of the vocabulary included 8 categories: “Politics”, “Science”, “Medicine”, “Literature”, “Children”, “Generalities”, “Education”, and “Others”. The reports randomly sampled the content of newspaper and magazines published in 1992 and 1993 and the partial content of bestsellers in 1993 as well as Chinese textbooks for elementary and junior high school students. The reports collected the vocabulary used daily, and we choose that to be the pool of our material from which to develop 40 remote associate items and 40 close associate items, for a total are 80 items. Table 1 lists and compares the examples of remote and close associate items. The protocols for selecting the vocabulary and the control of confounding variables are stated as follows.

(1) The remote concept and the close concept

The reports defined the frequency of a noun as the number of times used in the sampled scopes. The positive correlation between the passing rate of remote associate items and the frequency of a two-character noun composed of stimulus and target characters was identified in a previous study (Chen & Wu, 2014), and the nouns with a higher frequency were easier to associate. Hence, in the present study we define close concepts as phrases whose occurrence frequencies ranked in the top 1/3 of all phrases, and remote concepts as those ranking in the bottom 1/3 of all phrases; the onomastic phrases in different domains were driven out in order to prevent background knowledge belonging to a specific domain from influencing the respondents’ answers. With the aforementioned protocols, we selected the remote vocabulary (mean of frequency is 2.38, SD = 0.54) and close vocabulary (mean of frequency is 32.58, SD = 20.57); the average frequencies of the two associate items are significantly different (t(78) = 16.07, p < 0.001).

(2) The associative amount of stimulus

To ensure the space of association while answering the items, we chose stimuli that could be composed of at least 20 two-character nouns; in other words, we selected the amount of association for the nouns that satisfied the first-third ranked phrases among all the nouns in the reports. We also controlled the amounts of association for remote associate items (Mean = 50.59, SD = 20.38) and close associate items (Mean = 50.58, SD = 17.90) to be equivalent (t(78) = 0.65, p = 0.52).

(3) The frequency of target nouns
To ensure both remote concepts and close concepts could be free associated during the task, we ensured that frequencies of all the nouns associated by the stimulus were equivalent (t(78) = 0.19, p = 0.85) in remote associate items (Mean = 31.94, SD = 23.69) and in close associate items (Mean = 31.35, SD = 24.65).

(4) The associative directions

The associative directions refer to forward association and backward association. To avoid the response set and to increase the difficulty of the test, we controlled the ratio of associative direction to be 3:5, including 45 forward associations and 75 backward associations, and randomly allocated the associative directions of stimuli in an item.

2.2.2. Divergent Thinking Test

The Divergent Thinking Test was developed by Wu et al. (1998) and is composed of two parts, the linguistic and graphic parts. We used the linguistic part. The task of the linguistic part is to associate the rare functions or creative uses of chopsticks, except for their use in dining; the result indicates three indices of creativity: fluency, flexibility, and originality.

To determine the reliability of the test, we collected the responses of 20 raters, and the coefficient of Kandall was used to indicate the internal consistencies for fluency (0.96), flexibility (0.97), and originality (0.94); after three or four months, the results of retest reliability were fluency (0.46), flexibility (0.44), originality (0.34). For validity, we used the performance of Torrance Tests of Creative Thinking as a criterion, and the criterion-related validity was determined for fluency (0.52–0.75), flexibility (0.47–0.62), originality (verbal, 0.08, 0.20; figural, 0.09, 0.57), and elaboration (0.39).

The performance of 49 samples was rated by a single rater and re-rated after one month; the re-test reliability was determined for fluency (0.98), flexibility (0.97), and originality (0.95).

2.2.3. Insight problems

We used the insight problems task by Chiu (2005), who developed and revised them based on the work of Ashcraft (2002), Perkins (2000), and Chen (2002). The total length is 6 items. To avoid confounding of practice effect that participants may have already seen any items of the task, we first checked the prior knowledge of our material with the participants. If they expressed that they already knew the answers, we would code their responses to the insight problems task to be missing values, and their answers did not count for credit. For the scoring, one correct answer was worth one credit, and a wrong answer did not count for credit. To avoid the influence of missing or invalid responses on the total score, the present study used passing rate (the correct answers / valid items).

The reliability and validity of the insight problems task was determined with a sample of 125 undergraduates, and the internal consistency α was 0.52 (Chiu, 2005) according to the protocol stated by Kline (1998), which was acceptable. For validity, the results of confirmatory factor analysis conformed to the overall model fit (χ2 (124) = 7.72, p > 0.05, CFI = 0.98, SRMR = 0.048, PNFI = 0.51, CFI = 1.00). These results showed that the insight problems task was indeed composed of a latent factor; in particular, all the coefficients λ were significant, the composite reliability was 0.51, and the insight problems task fit the internal structure of the model.

2.3. Procedure

The experiment was implemented in a group with participants using a computer and paper and pencil to complete three measures. At the beginning of the experiment, the researchers explained to the participants the purpose of the research and the timetable of all tasks, and the participants signed the informed consent forms; the experiment then began. The “Remote and Close Associate Items”, the “Divergent Thinking Test”, and the insight problems task were given in that order, and the time for completing each measure was 40, 10, and 10 min, respectively. The detail of the entire process is described as follows.

First, we used the “E-prime 2.0” to display the “Remote and Close Associate Items” on a computer screen one by one; each interval contained 16 items, with a total of 5 intervals, and the length of the test was 80 items, with a 3-min rest after each interval. Each item was on screen for 30 s, and when participants thought of the answer within the time limit, they could press the button to proceed to the answer page and write down the answers on the answer sheet; participants moved to the next item when they finished the present one. If they failed before the time limit, they had to skip the present item and move to the next one.

After all participants finished the “Remote and Close Associates Tests”, the researchers would read the instructions of the “Divergent Thinking Test” and the insight problems task. Participants wrote down the unusual use of chopsticks with free association and answered the insight problems task on the answering sheet; a time-limit for each of these tasks was also given.

2.4. Data analysis

To enhance the CRAT and generate a more effective measurement of creativity, we used the following statistical data to verify the effectiveness of our CRAT, including the passing rates and response times of remote associate items as well as close associate items, the passing rate of insight problems, and the fluency, flexibility, originality, and overall score of the
Table 2
The passing rates and problem-solving times of the remote and close associate items for high and low creativity groups.

<table>
<thead>
<tr>
<th></th>
<th>High Creativity Group (N=24)</th>
<th>Low Creativity Group (N=25)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
<td>SD</td>
</tr>
<tr>
<td>Passing rate</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Remote Associate Items</td>
<td>0.22</td>
<td>0.07</td>
</tr>
<tr>
<td>Close Associate Items</td>
<td>0.43</td>
<td>0.10</td>
</tr>
<tr>
<td>Problem-solving time</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Remote Associate Items</td>
<td>14.41</td>
<td>2.99</td>
</tr>
<tr>
<td>Close Associate Items</td>
<td>12.75</td>
<td>2.15</td>
</tr>
</tbody>
</table>

Table 3
Correlations for the scores of remote and close associations, divergent thinking, and insight problem (N=49).

<table>
<thead>
<tr>
<th></th>
<th>Fluency</th>
<th>Flexibility</th>
<th>Originality</th>
<th>Divergent thinking</th>
<th>Insight</th>
</tr>
</thead>
<tbody>
<tr>
<td>Remote association</td>
<td>0.43*</td>
<td>0.30*</td>
<td>0.34*</td>
<td>0.39*</td>
<td>0.24*</td>
</tr>
<tr>
<td>Close association</td>
<td>0.20</td>
<td>0.07</td>
<td>0.19</td>
<td>0.17</td>
<td>0.11</td>
</tr>
</tbody>
</table>

*p < .10; **p < .05; ***p < .01.

“Divergent Thinking Test”. For data analysis, a paired-T-test was used to compare the passing rate and response time of the remote associates test and close associate test, so that we could determine the differences in the accessibility and the time consumption of remote concept and close concept items for individuals. Then, the correlations among the passing rates of “Remote and Close Associate Items” and each dimension of the “Divergent Thinking Test”, as well as the correlations between the passing rates of “Remote and Close Associate Items” and the insight problems task are discussed; by investigating these relationships, we determined how well the performance in the “Remote and Close Associate Items” task reflected the level of creativity. Finally, participants were grouped into high creativity and low creativity groups by their median score on the “Divergent Thinking Test”, and we compared the passing rates of the “Remote and Close Associate Items” as well as the interaction of the response time by group. This study also investigated the associative hierarchy of Association theory and provided more theory support for the CRAT.

3. Result

3.1. The passing rates and problem solving times for remote and close associate items

The results show that the passing rate of close associate items (M = 0.41, SD = 0.10) was higher than that of remote associate items (M = 0.19, SD = 0.07) (t(48) = −16.96, p < .001, d = −2.55), indicating it was more difficult for individuals to think of the correct answers in remote associate items than in close associate items. In addition, it took more time to solve the remote associate items (M = 14.37, SD = 3.37) than the close associate items (M = 13.22, SD = 2.21) (t(48) = 3.89, p < .001, d = 0.61), thus demonstrating that for associating remote concepts, it took longer for individuals to arrive at the correct answers.

3.2. Performances of remote and close associate items in high and low creativity groups

In Table 2, we list the passing rates of remote and close associate items, and the mean and S.D. of problem-solving time. Regarding the passing rates, the results of ANOVA) shows that the interaction of creativity groups and the type of association was not significant (F(1,47) = 0.59, p = 0.45, η² = 0.01), but the main effect of the creativity groups was significant (F(1,47) = 6.30, p = 0.02, η² = 0.12), and the type of association was significant as well (F(1,47) = 284.65, p < .01, η² = 0.86). With respect to post hoc results, both the passing rate of remote associate items and that of close associate items were higher in the high creativity group than in the low creativity group. For the problem-solving response time, the result of analysis of variance (2 × 2 ANOVA) indicates that the interaction of the creativity groups and the type of association was not significant (F(1,47) = 0.03, p = 0.86, η² = 0.01); the main effect of the type of association was significant (F(1,47) = 14.78, p < 0.01, η² = 0.24), but the main effect of the creativity groups was not (F(1,47) = 2.20, p = 0.15, η² = 0.05). Participants spent much more time on the remote associate items than on close associate items.

3.3. The relationships of remote and close associations, divergent thinking, and insight

In Table 3, we show how the passing rates of remote and close associate items correlated to the fluency, flexibility, originality, and overall scores of divergent thinking as well as the insight problems task. The passing rate of remote association items was positively correlated to the performance of divergent thinking and the insight problems task (rs > 0.24, ps < 0.09), but the passing rate of close association was not significantly correlated to the performance of divergent thinking and insight problems task (rs < 0.20, ps > 0.16). Hence, there is a positive relationship between the constructs of remote associate items
and the performance of divergent thinking as well as the ability of insight problem solving. Conversely, the constructs of close associate items were not related to the ability of divergent thinking.

4. Discussion

The present study aims to develop a new approach to enhance the measurement of creativity by the Chinese Remote Associates Test. Different from previous approaches to designing the CRAT (Jen et al., 2004), the present study initially proposes to develop the CRAT by the associative hierarchies of the stimulus and the choosing of nouns with lower frequencies as the material of remote associate items. To contrast the performances of remote association and close association, we also developed the close associate items by selecting nouns with higher frequencies and correlated the performances of the two sets of associate items with the scores of other creativity tasks. The results show that fewer participants passed the remote associate items than the close associate items; participants also took more time to answer the remote associate items than the close ones. In addition, people with higher creativity correctly answered more items on the tests than people with lower creativity, both the remote associate items and the close associate items. The score of remote associate items was positively correlated to the performances of the “Divergent Thinking Test” and the insight problems task, but there was no significant correlation between the scores of close associate items and those of the creativity tasks. The aforementioned results support our approach to develop the CRAT, which is more effective in measuring the creativity than previously. Results also support the Association theory with empirical data.

Remote association is when individuals free associate concepts with weak relations around the targets. In Association theory (Mednick, 1962; Martindale, 1981, 1995), it was easier for individuals to link the close concepts than the remote concepts. To be specific, remote concepts referred to the knowledge themes that were weakly associated and less possible to link with the target theme. Conversely, close concepts were easier to connect (Collins & Loftus, 1975; Gruszka & Necka, 2002). To develop the CRAT with the above definitions, remote or close concepts refer to the use frequencies of nouns. A noun with a higher frequency is more often used in daily life, so people would think of it easily; this noun is a close concept. A noun with a lower frequency is more seldom used in daily life, so it is harder for people to link it; this noun is a remote concept. The participants who solved the remote or close associate items did so only if they could access the corresponding remote concepts or close concepts. The present study improved the CRAT with aforementioned approach, and we found that the passing rate of the close associate items was far higher than that of the remote associate items; results supported our approach. Thus, our way of control was effective in diminishing the confounding factors of the test results; for instance, we controlled the direction of association and the associative amount of stimulus (Chen & Wu, 2014). Also, by controlling the frequency of the target noun, the remote associate items and the close associate items were more effective for measuring the performance of remote concepts and close concepts association.

According to the hypothesis for the process of remote association, people would first link the close concepts that had strong connections to the theme and then, by way of divergent thinking, finally think of the remote concepts (Gough, 1976; Ward, 1969); thus remote association took longer than close association (Libby, 1970). Generally using the response time to measure the mental process (Hsieh, 2013; Posner, 1978), we also used this idea of response time record to uncover the process of remote association. The results support our hypothesis: participants spent more time solving remote associate items than close associate items, which means that remote association requires more time. The difference in response time for the remote and close associate items also indicates that the ability of remote association could be effectively measured by the CRAT in the present study.

In addition, the passing rate of remote associate items was higher in the high creativity group than in the low creativity group as was the passing rate of close associate items. This result partially supports the finding that people have different concepts for associative models of associative hierarchies according to levels of creativity (Mednick, 1962), and people with high creativity link more remote concepts. The reason for this finding might be the difficulties of the items in the present study as the close associate items were relatively simpler than the remote ones. However, the means of control in the present study, such as control of the associative direction, moderated the difficulties of our items, but they still somewhat difficult (Mean = 0.41), which was not reflected in the close association concept. Similar results were found in previous research when Lin et al. (2005) assigned the participants into high and low creativity groups by the task of “2 4 6” and took the response time difference of the vocabulary tasks as the index of associative strength; they also found that the high creativity group had more associative strength of remote and close concepts than the low creativity group. Thus it may be necessary to modify the statement regarding the strength effect of associative hierarchy (Ward, 1969).

With respect to the scores of remote associate items and the performances of other creativity tasks, the results are consistent with our hypothesis: the score of remote associate items and the performance of the insight problems task were positively correlated. Consistent with the findings in previous research, the process of remote association and the process of insight are alike (Huang et al., 2012; Bowden & Jung-Beeman, 2003a; Lubart, 1994), with people having an “A-ha!” experience in both processes; thus a remote associates test could be a kind of insight problems task (Bowden & Jung-Beeman, 2003b). Although the close associate items and insight problems task share the same type of structure, i.e., an open-ended question with a close-ended answer (Wakefield, 1992), the score of close associate items is not significantly related to the performance of the insight problem task. To access a close concept is easy but solving an insight problem requires a novel and remote association. The results also show that different cognitive functions operate during the tasks of remote associate items and close ones, with the performance of remote associate items and insight being alike.
Previous studies claimed that the remote associates test was not significantly related to the performance of the divergent thinking test (Huang et al., 2012; Belcher & Davis, 1971). Our results support the correlation between remote association and divergent thinking, with the performance of the remote associates test being positively correlated to the fluency, flexibility, originality, and overall score of the Divergent Thinking Test; thus, remote association and divergent thinking may be similar in process. According to the Association theory (Mednick, 1962) and the “Spreading-Activation Theory of Semantic Processing” (Collins & Loftus, 1975), individuals would begin remote association with serial searching for the close concept that was highly relevant to the target theme, then extend their searching to a remote concept with less relation, and finally arrive at the correct answer. In divergent thinking, individuals develop various types of concepts and have novel ideas by way of free association (Plucker & Renzulli, 1999). In short, remote association and divergent thinking are similar in the rich connections between the concepts and that in the end, they have something original and novel. The aforementioned process is supported by the results of present study that found remote association was highly correlated to fluency and originality; conversely, close association was not related to the performance of divergent thinking. These results again indicate that the CRAT developed in the present study is effective for measuring creativity.

Our CRAT has low correlation to performance of insight problems, which is not consistent with the results of the Chinese Word Remote Associates Test (CWRAT) or compound remote associate problems (CRAP) (Huang et al., 2012; Bowden & Jung-Beeman, 2003a). There are two possible reasons for this. First, the CRAT of the present study emphasizes that the individual would obtain the answer only by reaching remote concepts; therefore, the problem-solving process of our CRAT is similar to the process of divergent thinking and different from the process of insight problem-like tests, such as CWRAT and CRAP. Second, the present study selected the stimuli from two-character nouns, which is different from the single-character searching by word-pairing or word-associating in CWRAT and CRAP. Even though the CRAT, CWRAT, and CRAP have the same form of items with finding of a target character using three stimuli, the lexical levels were different (nouns vs. single character), which might target different inner problem-solving processes.

There are limitations of our results. First, the sample size was not large enough, and we could not do an item analysis, examination of reliability and validity, or even an approach of item response theory (IRT). Second, the passing rate of the remote associates test was low, which might have a floor effect. We suggest further study to slightly decrease the standard of selecting remote associate items with higher occurrence frequency of words, but this would still need to consider the significant correlations between the performance of high occurrence frequency items and that of the divergent thinking test.

The present study initiates a new approach by choosing low-frequency nouns in the associative hierarchy of the stimulus character in order to develop the items of the Chinese Remote Associates Test (CRAT). We can understand how people respond differently to the remote associate items and close associate items by their passing rate, response time, and in the correlation with other creativity tasks. With these empirical data, we can tell the difference between remote association and close association and measuring the ability of remote association will be more efficient. Suggestions for future research include acquiring more comprehensive information on reliability and validity, collecting data in different age ranges for generalization to more subjects; and investigating the mechanism of remote association in the process of creativity, which would be a helpful measurement for related research, such as eye-movement tracking (Tseng, Chen, Chen, Sung, & Chang, 2014) and cognitive neuroscience (Bowden & Jung-Beeman, 2003b; Bowden, Jung-Beeman, Fleck, & Kounios, 2005; Wu, Zhong, & Chen, 2016).

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