Effects of the interaction between exercising self-control and PhoPhiKat on divergent and convergent thinking

Fa-Chung Chia,⁎, Chih-Chun Hsusb, Yao-Nan Lin, Hsueh-Chih Chenb,d, Cheng-Hong Liu

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ABSTRACT

This study investigated how the interaction between exercising self-control and PhoPhiKat disposition influences divergent and convergent thinking. In Study 1, 77 university students completed the PhoPHiKat-45 before being randomly assigned to the exercising self-control or neutral group. After experimental manipulation, participants were asked to complete the divergent thinking test. The results indicate that the students with high gelotophilia in the exercising self-control group were more fluent and flexible in generating ideas compared with those in the neutral group. Regarding originality, compared with the students with low katagelasticism, the students with high katagelasticism in the self-control group demonstrated a higher degree of originality than those in the neutral group. In Study 2, 66 students were randomly assigned to the exercising self-control or neutral group, and the dependent variable was the convergent thinking test (i.e., the critical thinking test). The results show that those with high gelothophobia in the self-control group demonstrated a higher degree of convergent thinking than did those in the neutral group. However, those with low gelothophobia in the neutral group exhibited a higher degree of convergent thinking compared with those in the self-control group. Thus, PhoPhiKat dispositions influenced the effect of exercising self-control on divergent and convergent thinking.

1. Introduction

In the twenty-first century, creative thinking (e.g., divergent thinking), critical thinking (which is a type of convergent thinking), and problem solving are considered necessary abilities (Kalelioglu & Gulbahar, 2014), as well as core abilities for work (Shalley, Zhou, & Oldham, 2004). Therefore, a comprehensive exploration of the factors influencing divergent and convergent thinking is crucial.
Self-control is a fundamental ability, particularly given the numerous temptations they are faced with in society. To live a successful and happy life, people must possess some ability to resist temptation (Huang, Liu, & Zhu, 2015); thus, exercising self-control (e.g., quitting smoking; Wilson, Sayette, & Fiez, 2014, and dieting to lose weight; Leahey, Xu, Unick, & Wing, 2014) is a crucial ability. Previous studies have explored how individuals’ ability to exercise self-control influences their divergent and convergent thinking. Regarding convergent thinking, previous studies have shown that after exercising self-control, people become less able to solve analytical problems (Schmeichel, Vohs, & Baumeister, 2003) and anagrams (i.e., convergent thinking; Baumeister, Bratslavsky, Muraven, & Tice, 1998). However, Chiu (2014) found that after exercising self-control, people exhibit enhanced ability to improve divergent thinking, indicating that exercising self-control influences divergent and convergent thinking differently.

Other variables can moderate the degree of influence that exercising self-control has on divergent and convergent thinking. The moderating variable investigated in this study was dispositions toward laughter and ridicule. Previous studies have found that conscientiousness negatively correlates with gelotophobia and katagelasticism (Durka & Ruch, 2015; Ruch, Harzer, & Proyer, 2013). Dispositions toward laughter and ridicule are common in interpersonal communication, and understanding how they moderate the influence of exercising self-control on divergent and convergent thinking is crucial. Ruch and Proyer (2009) categorized dispositions toward laughter and ridicule into three types: gelotophobia (fear of being laughed at), gelotophilia (enjoyment of being laughed at), and katagelasticism (enjoyment of laughing at others). People exhibit various responses when they are laughed at: Some people are fearful of being laughed at (gelotophobes), some enjoy being laughed at (gelotophiles), and some enjoy laughing at others (katagelasticists; Ruch & Proyer, 2008). These three concepts are collectively known as PhoPhiKat. Because of the three dispositions toward laughter and ridicule, the influence of exercising self-control on divergent and convergent thinking differs. This study was conducted to investigate how PhoPhiKat moderates the relationship between exercising self-control and divergent and convergent thinking.

1.1. Divergent and convergent thinking

Divergent thinking implies that one person can propose multiple or unique solutions for a problem or task (Guilford, 1967). An example is Guilford’s Alternative Uses Test, in which participants must create as many uses for a simple object (e.g., a pen) as they can think of. Test results are evaluated according to the indicators of fluency (i.e., the ability to generate numerous ideas), originality (i.e., the ability to generate novel ideas), and flexibility (i.e., the ability to generate ideas for several conceptual categories).

In contrast to divergent thinking, convergent thinking refers to the ability to generate an optimal solution for a particular problem (Reitman, 1965). The crucial aspect of convergent thinking is that the most appropriate answer must be derived without ambiguity, with all answers dichotomized as being either correct or incorrect (Cropley, 2006). Convergent thinking tasks include critical thinking (Watson & Glaser, 1994), reasoning (Cheng, Holyoak, Nisbett, & Oliver, 1986), grammatical transformation of a logical proposition (Chamorro-Premuzic & Reichenbacher, 2008), and creating anagrams (Walker, Liston, Hobson, & Stickgold, 2002). In the present study, we used the “unusual uses for newspapers” test (Hsu, Chen, & Chiu, 2012) to measure divergent thinking as well as a critical thinking test (Chen, Chen, Chen, & Chen, 2006) to measure convergent thinking.

1.2. PhoPhiKat

Titze (1996) first proposed the concept of gelotophobia, and Ruch and Proyer (2009) later proposed the concepts of gelotophilia and katagelasticism. The three concepts are explicated as follows.

According to Titze (1996, 1997), gelotophobes cannot positively evaluate laughter or smiles, appreciate humor, or consider such behaviors as acts of joy; by contrast, they consider laughter to be threatening. Gelotophobes fear being laughed at because they believe that they are being ridiculed; consequently, they lack vitality, spontaneity, and enjoyment, and they tend to have low self-esteem. Gelotophobes are extremely sensitive to derogatory humor (Ruch & Proyer, 2009). Therefore, their negative responses to a supportive smile or friendly laugh indicate that they are fearful of being criticized or insulted by people exhibiting such behaviors. Titze has indicated that gelotophobes typically have a rigid posture because of muscle tightness resulting from their anxiety. By contrast, when gelotophiles are laughed at, they do not feel ashamed. They often laugh at themselves to entertain other people, and they enjoy telling jokes and interesting stories (Ruch & Proyer, 2009). Katagelasticists enjoy laughing at other people and often observe others, taking every opportunity to make fun of them. Katagelasticists do not consider laughing at other people to be inappropriate behavior (Ruch & Proyer, 2009).

Ruch and Proyer (2009) demonstrated that gelotophobia and katagelasticism are uncorrelated, whereas gelotophobia correlated negatively with gelotophilia; therefore, gelotophobes do not actively laugh at themselves to entertain other people. Gelotophilia, however, correlated positively with katagelasticism, indicating that gelotophiles not only tend to make fun of themselves to entertain other people, but also tend to laugh at other people when the opportunity presents. To measure the three dispositions toward ridicule and being laughed at, Ruch and Proyer (2009) developed the PhoPhiKat questionnaire (Pho, Phi, and Kat represent gelotophobia, gelotophilia, and katagelasticism, respectively), which was employed in the present study to measure these three dispositions.

1.3. Moderating influence of PhoPhiKat on the relationship between exercising self-control and divergent and convergent thinking

The research hypotheses proposed in this study were derived from the relationships among conscientiousness, PhoPhiKat, trait self-control (TSC), convergent thinking, and divergent thinking. Ruch et al. (2013) indicated that conscientiousness was uncorrelated with gelotophobia but negatively correlated with gelotophilia and katagelasticism. Ďurka and Ruch (2015) found that conscientious-
ness did not predict gelotophobia but negatively predicted gelotophilia and katagelasticism. Therefore, conscientiousness is uncorrelated with gelotophobia but negatively correlated with gelotophilia and katagelasticism. Conscientiousness refers to the propensity to be self-controlled, responsible toward others, hardworking, orderly, and rule abiding (Roberts, Jackson, Fayard, Edmonds, & Meints, 2009). Duckworth and Gross (2014) indicated that self-control resembles ego strength, effortful control, and conscientiousness. TSC refers to the ability to control behavior and act according to intentions (Carver, 2005; De Ridder, Lensvelt-Mulders, Finkenauer, Stok, & Baumeister, 2012; Tangney, Baumeister, & Boone, 2004). Regarding prediction, higher conscientiousness predicts higher cognitive ability (Connor & Paunonen, 2007), higher job performance (Dudley, Orvis, Lebiecki, & Cortina, 2006), and lower food intake. TSC can predict future academic achievements and attainments (Duckworth & Carlson, 2013; Mischel, 2014; Zimmerman & Kitsantas, 2014), the tendency to reduce food intake (Haynes, Kems, Moffitt, & Mohr, 2014), the inhibiting of impulse behaviors, and tolerance to pain (Schmeichel & Zell, 2007). Moreover, low TSC correlates positively with delinquency (Meldrum, Barnes, & Hay, 2015). In summary, conscientiousness is related to TSC in concept; in addition, conscientiousness can predict TSC-related behaviors because of its positive correlation with TSC. Therefore, the relationship between PhoPhiKat and TSC may be similar to that between PhoPhiKat and conscientiousness. The following paragraphs describe the meaning of exercising self-control and the influence of the interaction between TSC and exercising self-control on divergent and convergent thinking. Finally, the research hypotheses are proposed.

Self-control refers to the interaction between two competing forces: one force is impulse motivation and the other is a force that overridges impulses. Self-control succeeds when a strong control competes with a weak impulse; conversely, self-control fails when a strong impulse competes with a weak control (Schmeichel, Harmon-Jones, & Harmon-Jones, 2010). Therefore, self-control is the capacity to inhibit thoughts, desires, impulses, and behaviors (Baumeister et al., 1998). In this study, two types of self-control were proposed: exercising self-control (manipulated state) and TSC (trait). Regarding the difference between exercising self-control and TSC, TSC is a general self-control ability that covers multiple domains (Imhoff, Schmidt, & Gerstenberg, 2013) and regulates thoughts, emotions, impulses, and performance (e.g., Baumeister, Heatherton, & Tice, 1994), whereas exercising self-control is a state in which individuals must impose upon themselves to refrain from engaging in certain behaviors (Schmeichel et al., 2010). The next paragraph describes the specific procedures for exercising self-control.

According to the resource model of self-control, the inner mechanism of self-control is established under the assumption of limited resources. Therefore, if individuals exercise self-control this deplete their resources, which may lead to their self-control failing (Baumeister, Gailliot, DeWall, & Oaten, 2006; Muraven & Baumeister, 2000). Whether self-control can override an impulse partially depends on previous behaviors. If a person has previously exercised self-control and depleted his or her impulse-control strength, then that self-control is more likely to fail. This reasoning indicates that after a person has exercised self-control, he or she has reduced self-control strength. The typical paradigm for testing a resource model of self-control comprises two conditions, for which participants must complete two consecutive tasks. For example, Schmeichel et al. (2003) found that after people have exerted self-control on an initial task, they tend to be less successful in solving subsequent reasoning and thinking problems, and more prone to spending money impulsively (Vohs & Baumeister, 2004), more aggressive in responding to others (Stucke & Baumeister, 2006), and less capable of performing well on arithmetic and intelligence tests (Bertrams, Baumeister, Englert, & Furley, 2015). In other words, after people exercise control over their behavior, their self-control resources decrease and thus their self-control ability is also reduced.

Next, the authors discuss how exercising self-control affects convergent thinking. Logic, reasoning, and problem solving require people to exercise active self-control (Schmeichel et al., 2003), construct a mental model, ignore irrelevant information, and exert cognitive control when processing information (Yang & Johnson-Laird, 2001). These mental functions may share the same mechanism as self-control (Baddeley, 1996; Barley, 1997; Broadbent, 1977; Norman & Shallice, 1986). Therefore, exercising self-control renders people unable to control their thoughts, resulting in a failure in logical reasoning and problem solving (i.e., convergent thinking tasks). An empiric study by Baumeister et al. (1998) involved instructing participants in an emotional suppression group (i.e., exercising self-control) to conceal their emotions while watching a movie, whereas participants in a no-self-control group were allowed to freely express their emotions while watching the movie. The results showed that the participants in the emotional suppression group performed significantly worse than those in the no-self-control group regarding the number of anagrams they solved correctly. Other studies have reported similar results (Bertrams et al., 2015; Schmeichel, 2007; Schmeichel et al., 2003). Therefore, the act of exercising self-control can impair convergent thinking.

Regarding how exercising self-control influences divergent thinking, Schmeichel et al. (2010) proposed that it increases approach motivation. This is the proposition of the approach-motivated impulse strength model, which was developed and inferred from the reinforcement sensitivity theory structure (Garr, 2008). Schmeichel et al. proposed that lowering a person's behavioral inhibition system (BIS) may increase the activation of their behavioral activation system (BAS), resulting in an increase in approach motivation. In other words, after a person exercises self-control, their BIS becomes relatively deactivated, whereas their BAS becomes more activated. Schmeichel et al. found that, after exercising self-control, participants exhibited improved BAS. On the basis of the approach-motivated impulse strength model (Schmeichel et al., 2010), Chiu (2014) proposed that exercising self-control could enhance creativity. Chiu provided the following theoretical foundations: (a) exercising self-control increases BAS activation (Schmeichel et al., 2010); (b) the constructs of approach motivation (i.e., BAS) and the promotion focus of regulatory focus are correlated (Summerville & Roese, 2008); and (c) the promotion focus can increase creativity (Friedman & Förster, 2000, 2001, 2002). Therefore, exercising self-control could increase creativity. In empirical studies, Chiu has instructed participants to write a travel story without using two Chinese radicals (i.e., “弋” and “口”) in order to reduce the participants' ability to exercise self-control. The results showed that the participants' subsequent divergent thinking ability improved.

On the question of how TSC interacts with self-control (i.e., exercising self-control) and influences subsequent processes, a group of researchers proposed that high-TSC participants should be less vulnerable to self-control depletion because they have
comparatively more resources before reaching the point of depletion (Dvorak & Simons, 2009). Specifically, high TSC has a protective effect on the requirement of exercising self-control. In an empirical study, DeWall, Baumeister, Stillman, and Gailliot (2007) requested participants to remove all instances of the letter e (337 instances in total). Participants in a neutral group were then asked to remove instances of the letter e from a new sheet of paper. While exercising self-control, the participants were asked to remove all instances of the letter e, except where the previous one or two letters were vowels. The results revealed that, relative to the high-TSC participants, the low-TSC participants demonstrated an increased level of intention to aggress when exercising self-control, indicating that after exercising self-control, the participants with low-TSC had low resources for self-control, resulting in an increase in aggressive behaviors. Therefore, when the high-TSC participants exercised self-control, they consumed fewer self-control resources.

People with low TSC possess fewer self-control resources; convergent thinking for solving logical problems requires self-control resources (Schmeichel et al., 2003). Therefore, after exercising self-control, people with low TSC may display impaired convergent thinking. In addition, regarding divergent thinking, people with low TSC also have low BIS, which can improve BAS (Schmeichel et al., 2010) and divergent thinking (Chiu, 2014). Therefore, people with low TSC exercise self-control, their approach motivation can be enhanced (Chiu, 2014). Furthermore, approach motivation can enhance divergent thinking (Chiu, 2014; Friedman & Förster, 2000, 2001, 2002). Accordingly, after exercising self-control, people with low TSC exhibit high performance in divergent thinking. As mentioned, gelotophobia and katagasticism correlate negatively with conscientiousness, and conscientiousness is positively correlated with TSC. Therefore, gelotophobia and katagasticism are likely to be negatively correlated with TSC. The influence of the interaction between PhoPhiKat and exercising self-control on divergent and convergent thinking can be understood by examining the influence of the interaction between TSC and exercising self-control on divergent and convergent thinking. In other words, high gelotophobia and katagasticism can facilitate exercising self-control to improve divergent thinking while inhibiting convergent thinking. Additionally, because gelotophobia is not correlated with conscientiousness, it may not moderate the relationship between exercising self-control and divergent or convergent thinking.

As discussed, it is possible that PhoPhiKat moderates the influence of exercising self-control on divergent and convergent thinking. Accordingly, the following research hypotheses are proposed:

**Hypothesis 1.** Compared with low gelotophilia, high gelotophilia has a stronger effect in enhancing the influence of exercising self-control on divergent thinking.

**Hypothesis 2.** Compared with low katagasticism, high katagasticism has a stronger effect in enhancing the influence of exercising self-control on divergent thinking.

**Hypothesis 3.** Gelotophobia does not moderate the relationship between exercising self-control and divergent thinking.

**Hypothesis 4.** High gelotophilia has a stronger effect than low gelotophilia in reducing the influence of exercising self-control on convergent thinking.

**Hypothesis 5.** High katagasticism has a stronger effect than low katagasticism in reducing the influence of exercising self-control on convergent thinking.

**Hypothesis 6.** Gelotophobia does not moderate the relationship between exercising self-control and convergent thinking.

### 2. Present study

This study examined how PhoPhiKat moderates the relationship between exercising self-control and divergent and convergent thinking. On the basis of the relationships between PhoPhiKat and conscientiousness and between conscientiousness and TSC, we inferred that PhoPhiKat is correlated with TSC and thus proposed the research hypotheses. If empirical results related to the correlation between PhoPhiKat and TSC can be verified, the research hypotheses can be supported. Therefore, a pilot study was conducted to examine the correlation between PhoPhiKat and TSC and verify the research hypotheses. Subsequently, Study 1 was conducted to examine how PhoPhiKat moderates the relationship between exercising self-control and divergent thinking, and Study 2 was conducted to examine how PhoPhiKat moderates the relationship between exercising self-control and convergent thinking. Thus, two studies were conducted to test the six research hypotheses.

#### 2.1. Pilot study

A pilot study was conducted to examine the correlation between PhoPhiKat and TSC. The brief PhoPhiKat-45 scale developed by Ruch and Proyer (2009) was used to measure PhoPhiKat, and the Brief Self-Control Scale (BSCS) developed by Tangney et al. (2004) was employed to measure the general long-term stability of the participants’ self-control tendencies.

#### 2.1.1. Methods

**2.1.1.1. Participants.** The participants of this study were 48 university students from Taiwan (23 men, 48%; 25 women, 52%; M _age_ = 22.78 years; SD = 3.94).

**2.1.1.2. Materials**

**2.1.1.2.1. PhoPhiKat scale.** This study used the traditional Chinese version of Ruch and Proyer’s PhoPhiKat-45 scale (Chen,
Table 1
Pearson correlations between TSC and PhoPhiKat.

<table>
<thead>
<tr>
<th></th>
<th>M</th>
<th>SD</th>
<th>1</th>
<th>2</th>
<th>3</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Gelotophobia</td>
<td>32.32</td>
<td>7.86</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. Gelotophilia</td>
<td>37.09</td>
<td>7.92</td>
<td>- .10</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. Katagelasticism</td>
<td>27.04</td>
<td>7.59</td>
<td>.38</td>
<td>.36</td>
<td></td>
</tr>
<tr>
<td>4. TSC</td>
<td>54.63</td>
<td>7.59</td>
<td>- .26</td>
<td>- .40</td>
<td>- .55</td>
</tr>
</tbody>
</table>

* p < .05.
** p < .01.

Chan, Ruch, & Proyer, (2011). The original PhoPhiKat-45 scale was adopted to measure gelotophobia (e.g., “When other people laugh in my presence, I become suspicious”), gelotophilia (e.g., “I seek situations in everyday life, in which I can make other people laugh at me”), and katagelasticism (e.g., “I enjoy exposing others and I am happy when other people laugh at them”). The scale comprises 45 items (15 items for each dimension), which are measured using a 4-point scale ranging from 1 (strongly disagree) to 4 (strongly agree).

In terms of reliability, the Cronbach’s coefficients were .85, .85, and .85, and the test-retest reliabilities were .92, .94, and .87, respectively. Regarding validity, goodness-of-fit indices and confirmatory factor analysis provided evidence for the construct validity of the scale (RMSEA = .058, CFI = .92; Chen et al., 2011).

2.1.2. Results
According to Table 1, TSC correlated nonsignificantly with gelotophobia (r = −.26, p = .08) but significantly and negatively with gelotophilia (r = −.40, p = .007) and katagelasticism (r = −.55, p < .001). This result is consistent with the inference reported in the literature. In other words, the interaction effect of TSC and exercising self-control on divergent and convergent thinking can be utilized to infer the interaction effect of PhoPhiKat and exercising self-control on divergent and convergent thinking. Thus, the results of the pilot study supplemented the inference gap in the research hypotheses.

2.2. Study 1
Study 1 was conducted to examine how PhoPhiKat moderates the relationship between exercising self-control and divergent thinking (Hypotheses 1–3). Regarding the experimental design, exercising self-control was taken as the independent variable for Study 1, which involved controlled-writing (i.e., exercising self-control) and a free-writing condition (i.e., the neutral group). In controlled-writing, exercising self-control was manipulated. The free-writing group was the control group. The method proposed by Chiu (2014) was adopted for manipulating exercising self-control. For the controlled writing condition, the participants were instructed to restrict their regular writing tendencies in order to manipulate their self-control activities. For the free-writing condition, the participants in the neutral group were not required to avoid their regular writing tendencies. Previous studies have manipulated self-control activities by asking participants not to use Chinese characters that contain the radicals “口” or “口” in their writing (Chiu, 2014). The moderator in Study 1 was PhoPhiKat, which was measured using the same method employed in the pilot study. Divergent thinking was considered a dependent variable and was measured using the “unusual uses for newspapers” test developed by Hsu et al. (2012).

In addition, previous studies have indicated that task-provided surprise (Filipowicz, 2006), constraints (Steidle & Werth, 2013), and frustration (Krug, Finn, Pietrowsky, Fehm, & Born, 1996) can influence task performance. Therefore, after exercising self-control was manipulated, the state of the three confounding variables was measured. Study 1 employed the single-item measurement method adopted by Friedman and Förster (2000, 2001, 2002, 2005) to measure these three variables. The items applied by Friedman and Förster were: “What is your present level of frustration?”; “When writing the story, what is your level of constraint?”; and “What is your level of surprise in this experiment?” For this experiment, a 7-point Likert scale was used to measure these states. In addition, word count, which can be used as an independent variable in the manipulation of story writing, could affect the internal validity of this study and was thus considered a confounding variable. Therefore, the four aforementioned variables were adopted as covariates.

2.2.1. Methods
2.2.1.1. Participants. The participants of this study were 77 university students from Taiwan (36 men, 43 women, M_age = 23.10 years, SD = 4.61).

2.2.1.2. Materials
2.2.1.2.1. Divergent thinking test. This study employed the “unusual uses for newspapers” test, which is a type of divergent thinking test developed by Hsu et al. (2012). The test requires participants to propose uncommon uses for newspapers and can
provide valuable results for the following three indicators: (a) fluency (the number of responses), (b) originality (unusual responses), and (c) flexibility (the number of response categories). Points were allocated according to the normative standard established by Hsu et al. to ensure scoring objectivity. Points were awarded for fluency if the participants proposed unusual uses for newspapers (valid responses), such as making a fire. By contrast, no points were awarded if the uses proposed common uses, such as reading the news. The total score for fluency indicated the number of valid responses. Points for flexibility were awarded according to the number of use categories in the valid responses. Each category was allocated 1 point, and the total number of categories reflected the flexibility score. Originality was scored on the basis of the incidence of a certain response among the total normative sample. If 5% or more of the sample provided the same response, no point was awarded. If 2–5% provided the same response, 1 point was allocated. If < 2% provided the same response, 2 points were awarded. The raters began scoring the experimental results after they thoroughly understood the scoring process. The intrarater reliability $r$ for the fluency, flexibility, and originality indicators were 0.99, 0.90, and 0.96, respectively (all $p < .001$). In relation to the unusual uses for chopsticks test designed by Wu et al. (1998), the criterion-related validity $r$ for the three indicators was 0.60, 0.41, and 0.72.

2.2.2. Procedures
The PhoPhiKat-45 Scale was first administered, and then the participants were randomly assigned to the controlled writing or free writing (neutral condition) group. First, the participants were required to complete a demographics questionnaire. Second, the participants in the free writing group were instructed to write a travel story. Their instructions were as follows: “Please write a story based on your latest travel experience. It could be a journey to a different country, county, city, or even a store. Please stop writing when requested by the experimenter.” For the controlled writing group, an additional instruction was included: “Please note that you are not allowed to write Chinese characters with the radicals ‘口’ or ‘艹’ when writing your story.” By contrast, the participants in the free writing group were allowed to write their stories without this restriction. The writing process lasted for 6 min, at which point the participants were instructed to cease writing. Third, the participants’ feelings of surprise toward the task as well as their feelings of constraint and frustration while participating in the experiment were measured. Finally, after completing the writing traveling story task, the participants were required to complete the unusual uses for newspapers test (5 min). At the end of the experiment, the experiment objective was explained to the participants, and NT$50 coupons were presented as tokens of gratitude.

2.2.3. Results
2.2.3.1. Manipulation check. To test the effectiveness of the manipulation of the independent variable (i.e., exercising self-control), the differences in word count and feelings of constraint among the participants in the two groups were compared. A $t$ test revealed that the word count of the participants in the controlled writing group ($M = 62.49, SD = 22.88$) was significantly less than that of the free writing group ($M = 96, SD = 47.47; t[52.40] = 3.95, p < .001$), indicating that the participants responded according to experimental instructions when exercising self-control. The self-control participants were prohibited from writing characters containing the radicals “口” or “艹,” resulting in comparatively lower word counts. In addition, when prohibited from writing certain Chinese characters, the participants experienced constraint. Therefore, for the constraint indicator, the scores of the participants in the controlled writing group ($M = 5.02, SD = 1.84$) were higher than those of the participants in the free writing group ($M = 3.76, SD = 1.37; t[75] = 7.10, p < .001$). These results indicated that the manipulation of exercising self-control was effective.

2.2.3.2. Divergent thinking. The measures of the three indicators (i.e., fluency, flexibility, and originality) were averaged ratings calculated by two raters, the intraclass correlations (two-way random model, definition of absolute agreement), of which the values were .99, .97, and .91, respectively. Accordingly, the scoring of the unusual uses for newspapers test was reliable.

A $t$ test was conducted to compare the divergent thinking performance of the controlled writing and free writing groups. The results showed that the controlled writing group exhibited higher fluency ($M = 13.12, SD = 4.78$) compared with the free writing group ($M = 10.16, SD = 4.54; t[75] = 2.82, p = .006, Cohen’s $d = 0.63$). The controlled writing condition also demonstrated greater flexibility ($M = 8.76, SD = 2.18$) compared with the free writing group ($M = 7.00, SD = 2.48; t[75] = 3.35, p = .001, Cohen’s $d = 0.75$). The originality scores of the controlled writing group ($M = 10.84, SD = 5.56$) were higher than those of the free writing group ($M = 7.21, SD = 4.82; t[75] = 3.09, p = .003, Cohen’s $d = 0.70$). The results of this experiment indicated that after the participants exercised self-control, their performances in all three indicators of divergent thinking were enhanced.

Study 1 primarily tested the effectiveness of PhoPhiKat in moderating the relationship between exercising self-control and divergent thinking. To determine the effects of exercising self-control (dummy variable: controlled writing group = 1; free writing group = −1), PhoPhiKat ($z$-value), and their interaction effect (product term) on the participants’ divergent thinking (fluency, flexibility, and originality), we conducted three 3-step hierarchical regression analyses. In the analysis, the performance of the participants in divergent thinking was the outcome variable. The results of the manipulation check indicated that the manipulation of the controlled writing task resulted in a comparatively higher word count compared with the free writing task. To control the confounding effects of the two variables, they were included in the regression model. In addition, to control the possible influences of the four variables on the regression model, the word count, feelings of surprise, constraint, and frustration were included as controlled variables. Therefore, in the first step, the story-writing variables of word count and feelings of surprise, constraint, and frustration were input to control the influence of these variables on the model. In the second analysis step, exercising self-control and PhoPhiKat were considered as predictors for examining the effects of exercising self-control and PhoPhiKat on divergent thinking. In the third step, the two-way interaction between exercising self-control and PhoPhiKat was added.

Regarding fluency, the results in Table 2 indicate that gelotophilia moderated the relationship between exercising self-control and fluency ($\beta = .31, p = .03$). However, the moderating effects of gelotophobia and katagelasticism were not observed ($\beta$s < .18,
To examine the source of the significant two-way interaction, a simple slope regression analysis recommended by Aiken, West, and Reno (1991) was conducted on fluency of low gelotophilia (−1 SD) and high gelotophilia (+1 SD) in both writing groups. Fig. 1 indicates that the simple slope of high gelotophilia was significant (β = .48; p = .004), whereas that of low gelotophilia was nonsignificant (β = .13, p = .47). These results demonstrate that the participants with high gelotophilia improved their fluency after exercising self-control, whereas those with low gelotophilia did not improve their fluency after exercising self-control.

Regarding flexibility, the results (see Table 2) show that gelotophilia moderated the relationship between exercising self-control and flexibility (β = .35, p = .01). However, the moderating effects of gelotophobia and katagelasticism were not observed (βs < .17, ps > .28). A simple slope regression analysis was conducted on flexibility for the low and high levels of gelotophilia in the two writing groups. Fig. 2 indicates that the simple slope of high gelotophilia was significant (β = .55; p = .001), whereas that of low gelotophilia was nonsignificant (β = .12, p = .49). These results indicate that the participants with high gelotophilia improved their flexibility after exercising self-control, whereas those with low gelotophilia did not.

Regarding originality, the results (Table 2) demonstrate that katagelasticism moderates the relationship between exercising self-control and originality (β = .26, p = .05). However, the moderating effects of gelotophobia and gelotophobia were not observed (all β < .10, ps > .48). A simple slope regression analysis was conducted on originality for the low and high levels of katagelasticism in two writing groups. Fig. 3 indicates that the simple slope of high katagelasticism was significant (β = .38; p = .02), and that of low katagelasticism was marginally significant (β = .35, p = .06). These results indicate that compared with the participants with low katagelasticism, those with high katagelasticism demonstrated a higher degree of originality after exercising self-control.

Table 2
Regression model for divergent thinking as predicted by exercising self-control, PhoPhiKat, and their interactions.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Fluency</th>
<th>Flexibility</th>
<th>Originality</th>
</tr>
</thead>
<tbody>
<tr>
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<td>B</td>
<td>β</td>
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<tr>
<td>Step 1</td>
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<td>−.31</td>
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<tr>
<td>F</td>
<td>3.11**</td>
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<tr>
<td>R² (%)</td>
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<td>36%</td>
<td>38%</td>
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Note: N = 77. All coefficients are reported for the final step.
* p < .05.
** p < .01.
† .05 < p < .10.

ps > .25). To examine the source of the significant two-way interaction, a simple slope regression analysis recommended by Aiken, West, and Reno (1991) was conducted on fluency of low gelotophilia (−1 SD) and high gelotophilia (+1 SD) in both writing groups. Fig. 1 indicates that the simple slope of high gelotophilia was significant (β = .48; p = .004), whereas that of low gelotophilia was nonsignificant (β = .13, p = .47). These results demonstrate that the participants with high gelotophilia improved their fluency after exercising self-control, whereas those with low gelotophilia did not improve their fluency after exercising self-control.

Regarding flexibility, the results (see Table 2) show that gelotophilia moderated the relationship between exercising self-control and flexibility (β = .35, p = .01). However, the moderating effects of gelotophobia and katagelasticism were not observed (βs < .17, ps > .28). A simple slope regression analysis was conducted on flexibility for the low and high levels of gelotophilia in the two writing groups. Fig. 2 indicates that the simple slope of high gelotophilia was significant (β = .55; p = .001), whereas that of low gelotophilia was nonsignificant (β = .12, p = .49). These results indicate that the participants with high gelotophilia improved their flexibility after exercising self-control, whereas those with low gelotophilia did not.

Regarding originality, the results (Table 2) demonstrate that katagelasticism moderates the relationship between exercising self-control and originality (β = .26, p = .05). However, the moderating effects of gelotophobia and gelotophobia were not observed (all β < .10, ps > .48). A simple slope regression analysis was conducted on originality for the low and high levels of katagelasticism in two writing groups. Fig. 3 indicates that the simple slope of high katagelasticism was significant (β = .38; p = .02), and that of low katagelasticism was marginally significant (β = .35, p = .06). These results indicate that compared with the participants with low katagelasticism, those with high katagelasticism demonstrated a higher degree of originality after exercising self-control.

Fig. 1. Interaction effects of exercising self-control and gelotophilia on fluency.
2.3. Study 2

Study 2 was conducted to examine how PhoPhiKat moderates the relationship between exercising self-control and convergent thinking (Hypotheses 4–6). In Study 2, except for the dependent variable being convergent thinking, the experimental design was identical to that in Study 1. Critical thinking refers to using logical skills (Paul, 1995), including reasoning and reflection. People use critical thinking to determine what to believe or what actions they should take. Thus, critical thinking is a type of convergent thinking. To measure critical thinking, Watson and Glaser (1994) developed the Watson–Glaser Critical Thinking Appraisal Form-S (WGCTA-FS), which covers the following five dimensions: inference (i.e., the ability to determine from given data whether a statement is true or false); recognition of assumptions (i.e., the ability to identify undeclared hypotheses from given descriptions); deduction (i.e., the ability to determine from given information whether a conclusion is correct); interpretation ability (i.e., the ability to discern whether a conclusion is derived according to given data); and evaluation of arguments (i.e., the ability to distinguish between strong and weak arguments). Thus, critical thinking is a type of rigorous, logical, and rational thinking. Logical thinking is a necessary ability to complete the WGCTA-FS; in addition, answers are either correct or incorrect. Therefore, the WGCTA-FS was considered suitable for measuring convergent thinking.

2.3.1. Methods

2.3.1.1. Participants. The participants of this study were 66 university students from Taiwan who were invited to participate in this study (23 men, 43 women, \( M_{\text{age}} = 24.00 \) years, \( SD = 3.11 \)).

2.3.1.2. Materials

2.3.1.2.1. Critical-thinking problems. Critical-thinking problems were used to measure convergent thinking in Study 2. They were translated into Chinese and revised by Chen et al. (2006) from the WGCTA-FS. The critical-thinking problems comprised five subscales (i.e., inference, recognition of assumptions, deduction, interpretation, and evaluation of arguments; Watson & Glaser, 1994). The WGCTA-FS items were descriptions of scenarios, and the participants were asked to respond to critical-thinking problems.
about these scenarios. One scenario was selected from each subscale, yielding 12 critical-thinking problems. Regarding the scoring system, each correct answer was allocated 1 point; thus, the maximum score was 12.

2.3.2. Procedures

In Study 2, apart from the divergent thinking test being changed to a convergent thinking task, the procedures were identical to those in Study 1.

2.3.3. Results

2.3.3.1. Manipulation check. To test the effectiveness of the experimental manipulation, the differences in word count and feelings of constraint between the two writing groups during the story-writing test were determined. The word count indicator from a t test revealed that the controlled writing group scored lower ($M = 66.28, SD = 23.27$) than those in the free writing group did ($M = 81.73, SD = 37.39; t[53.81] = 2.00, p = .05$). This result confirmed that the participants responded according to the experimental instructions. The participants in the controlled writing group were prohibited from writing Chinese characters containing the radicals “四” and “口”, resulting in comparatively low word counts compared with those observed in the free writing group. Regarding the indicator for feelings of constraint, the participants who exercised self-control (controlled writing group) experienced significantly stronger feelings of constraint ($M = 5.25, SD = 1.80$) than those in the free writing group ($M = 3.76, SD = 2.24; t[60.91] = 2.97; p = .004$), indicating that the manipulation in the exercising self-control test was effective.

2.3.3.2. Critical thinking. A t test was conducted to compare the convergent thinking performance between the two writing groups. The results showed that the controlled writing group exhibited the same degree of convergent thinking ($M = 6.88, SD = 1.98$) as the free writing group ($M = 6.73, SD = 1.75; t[64] = 33, p = .74$). Study 2 primarily verified that PhoPhiKat moderated the relationship between exercising self-control and convergent thinking. Similar to Study 1, three 3-step hierarchical regression analyses were used to test Hypotheses 4–6. However, for Study 2, the outcome variable was changed to the participants’ performance in convergent thinking (critical thinking).

The results (see Table 3) indicate that gelotophobia moderated the relationship between exercising self-control and convergent thinking ($\beta = .29, p = .01$). However, the moderating effects of gelotophilia and katagelasticism were not observed ($\beta_s < .16, ps > .28$). A simple slope regression analysis was conducted on convergent thinking for low and high gelotophobia in the controlled and free writing groups. Fig. 4 indicates that the simple slope of high gelotophobia was marginally significant ($\beta = .28; p = .08$), and that of low gelotophobia was marginally significant ($\beta = −.40, p = .07$). These results indicate that the participants with high gelotophobia improved their critical thinking after exercising self-control, whereas the opposite is true for the participants with low gelotophobia.

3. General discussion

The study results demonstrate that the main effects of exercising self-control can enhance divergent thinking, which is consistent with the result obtained by Chiu (2014). This raises the question of why exercising self-control enhances divergent thinking. The reason may be that BIS is reduced while BAS is enhanced after exercising self-control (Schmeichel et al., 2010); accordingly,

<table>
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<th>Variable</th>
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<tbody>
<tr>
<td>B</td>
<td>$\beta$</td>
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<tr>
<td>Step 1</td>
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<tr>
<td>Surprising</td>
<td>.76</td>
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<td>Exercising self-control * gelotophobia</td>
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<tr>
<td>$F$</td>
<td>2.47**</td>
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<tr>
<td>$R^2$ (%)</td>
<td>37</td>
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</table>

Note: $N = 66$. All coefficients are reported for the final step.

* $p < .05$.

** $p < .01$. 
divergent thinking improves (Chiu, 2014). This phenomenon can also be explained from the perspective of executive functions and inhibition control. Using inhibition control can reduce the corresponding cognitive resources and enhance divergent thinking. Because inhibitory control generates resistance to interference from irrelevant actions, inhibition limits the conscious awareness of goal-relevant information (Radel, Davranche, Fournier, & Dietrich, 2015). Consequently, the focus of attention is narrowed (Hasher, Lustig, & Zacks, 2007) and divergent thinking is reduced. Nevertheless, when inhibitory control does not function effectively, a broader range of information enters the working memory and thus enhances the performance of divergent thinking. Radel et al. found that when participants were requested to consume cognitive resources for inhibition control, their fluency and flexibility improved. These results support the aforementioned perspectives.

Regarding the main effects of exercising self-control on convergent thinking, not all participants exhibited a reduction in convergent thinking after exercising self-control. These results are inconsistent with the results of previous studies that support the resource model of self-control (e.g., Baumeister et al., 1998; Bertrams et al., 2015; Schmeichel, 2007; Schmeichel et al., 2003) but are consistent with those that do not support the resource model of self-control (e.g., Stillman, Tice, Fincham, & Lambert, 2009; Wright et al., 2007; Wright, Stewart, & Barnett, 2008). According to the resource model of self-control, when participants exercise self-control, the consequent depletion of self-control resources reduces convergent thinking (e.g., Bertrams et al., 2015). However, the results of Study 2 do not support the resource model of self-control. This raises the question of why, after exercising self-control, the participants’ convergent thinking was not reduced. Recent studies have suggested that when people engage in self-control (e.g., avoiding writing Chinese characters containing the radicals “犬” or “犬”), they experience aversive feelings (Botvinick, 2007). Consequently, they tend to avoid cognitive work. The self-control of resource depletion may motivate switching of task priorities, with participants increasingly averse to mental effort and mental leisure appearing increasingly attractive (Kool & Botvinick, 2014). That is, when engaged in self-control activities, the follow-up required to complete the work appears more attractive to participants, and enhances motivation. Regarding the experimental procedure of Study 2, it is possible to enhance the execution motivation and interest regarding the second task (i.e., the critical thinking test) and enhance the convergent thinking performance after exercising self-control. However, this argument can also explain why exercising self-control can improve divergent thinking in Study 1. In summary, after the participant is required to complete the self-control task, the participants’ performance in the convergent and divergent thinking may be enhanced by their motive for the subsequent task being raised.

Regarding PhoPhiKat moderating the relationship between exercising self-control and divergent thinking, the participants with high gelotophilia improved their fluency and flexibility after exercising self-control. These results support Hypothesis 1. However, exercising self-control did not enhance the fluency and flexibility of the participants with high katagelasticism, which does not support Hypothesis 2. Regarding originality, the participants with high katagelasticism exhibited enhanced originality after exercising self-control, which supports Hypothesis 2. However, after exercising self-control, the participants with high gelotophilia did not exhibit enhanced originality, which does not support Hypothesis 1. In addition, gelotophobia does not moderate the relationship between exercising self-control and divergent thinking, which supports Hypothesis 3. In conclusion, the results partially support Hypotheses 1 and 2, and Hypothesis 3 is supported.

Collectively, these results indicate that after the participants with high gelotophilia exercised self-control, their fluency and flexibility in generating ideas improved, although their originality was not enhanced. Furthermore, after exercising self-control, the participants with low self-control and high gelotophilia probably improved their association between knowledge nodes in various categories, but their originality did not improve, which requires remote association (Mednick, 1962). High katagelasticism exerted a different effect; specifically, in exercising self-control group, high katagelasticism did not enhance fluency or flexibility but improved originality. In the pilot study, the correlation coefficients between TSC and gelotophilia (−.40) and between TSC and katagelasticism (−.55) indicated that compared with gelotophiles, katagelasticists have less self-control and greater BAS after exercising self-control. Accordingly, their remote association between knowledge nodes was strengthened (Mednick, 1962) and their originality was enhanced.

Regarding convergent thinking, the participants with high gelotophilia or high katagelasticism did not exhibit reduced convergent thinking after exercising self-control, which does not support Hypothesis 4 or 5. As mentioned previously, the reason for the results of
Study 2 might be that, when engaged in self-control activities, the follow-up required to complete the work is more attractive to the participants, and enhances their motivation. The motivation for this convergent thinking task results in gelotophilia and katagelasticism not moderating the influences of exercising self-control on convergent thinking performance.

Notably, convergent thinking among high gelotophobes was enhanced after exercising self-control, whereas convergent thinking among low gelotophobes was impaired. This result does not support Hypothesis 6. This raises the question of why convergent thinking was enhanced among high gelotophobes after exercising self-control but reduced among low gelotophobes. This phenomenon can be explained from the perspective of regulatory fit. According to Hsu, Chen, and Chiu (2009), the prevention focus predictor affects gelotophobia. Prevention focus refers to a person’s objectives or motivation for risk aversion, which generates sensitivity to the presence or absence of negative outcomes; strategies for achieving prevention goals involve loss and failure avoidance (Lockwood, Jordan, & Kunda, 2002). Therefore, gelophobia is similar to certain facets of prevention focus. Regulatory fit indicates that a person’s regulatory-focus traits accord with the situation of regulatory focus. Factors influencing a person’s cognitive performance are related to his or her regulatory-focus motivation (Friedman & Förster, 2000, 2001, 2005), as well as the fit of regulatory-focus motivation. Regulatory fit can enhance the intensity of motivation (Higgins & Spiegel, 2004) and the fluency of cognitive processing (Lee & Aaker, 2004) and can enable people to “feel right” about what they are doing. When people exhibit a positive response to what they are doing, the effect of regulatory fit can reinforce the positive response (Higgins, 2000), thereby enhancing their performance. For example, Shah, Higgins, and Friedman (1998) examined a hypothesis regarding the fit of regulatory-focus motivation and found that people with prevention focus traits attained high performance on an anagram task in a prevention focus context. Keller and Bless (2006) indicated that when a person’s regulatory-focus motivation is consistent with his or her regulatory-focus traits, the person’s performance is enhanced. Therefore, regarding exercising self-control in the present study, the participants were requested to avoid writing Chinese characters containing the radicals “¥” or “壷.” This type of manipulation resembles the manipulation of a prevention focus context. For people with high gelotophobia, exercising self-control is a regulatory fit and thus their performance in convergent thinking can be enhanced; however, for people with low gelotophobia, exercising self-control is not a regulatory fit and thus their performance in convergent thinking deteriorates.

By contrast, Imhoff et al. (2013) showed that, relative to low-TSC participants, high-TSC participants consumed more candies after exercising self-control. These findings primarily suggested that, compared with low-TSC participants, high-TSC participants rarely actively inhibit their impulses (Hofmann, Baumeister, Förster, & Vohs, 2012) and therefore less frequently engage in the effortful inhibition of impulses (Hofmann et al., 2012). The active suppression of desires in everyday life provides individuals with increasing resistance against temptation (Baumeister et al., 1998; Gailliot et al., 2007). High-TSC individuals avoid tempting situations in everyday life; active inhibition against temptation becomes increasingly difficult. Therefore, when forced to exercise self-control against temptation, high-TSC individuals tend to exhibit a comparatively weak ability to resist temptation. Imhoff et al. produced consistent findings for this argument that high-TSC individuals rarely inhibit impulses in everyday life, demonstrating the detrimental effects of TSC (Imhoff et al., 2013). The results of the present study (a pilot study) indicate that TSC correlated marginally significantly with gelotophobia \( r = -0.26, p = .08 \), which demonstrates that people with high gelotophobia tend to be low-TSC individuals. In other words, high-gelotophobia (i.e., low TSC) individuals tend to have more frequent control over their own experiences, and therefore may be less resource-consuming when exercising self-control under experimental conditions, leading to a higher performance in convergent thinking.

In addition, there is the question of why gelotophilia similarly moderates the effects of exercising self-control on fluency and flexibility. This study found that the correlation between fluency and flexibility is .84; therefore, it is possible that these two indicators are highly correlated and lead to similar results. However, the correlation between fluency and originality is .80, raising the question of why gelotophobia does not exhibit a moderating effect on originality. Researchers have argued that the relation between fluency and originality is positive (e.g., Silvia, 2008). In contrast, others researchers have suggested that fluency and originality are highly separable constructs (e.g., Benedek, Fink, & Neubauer, 2006). The results of this study support the construction of fluency and originality as separable. However, originality is calculated differently, resulting in differences in the degree of correlation between fluency and originality. In this study, the algorithm of originality is based on the idea of the production of norm samples. Thus, if a participant is the only one in a sample to have generated a particular idea, that idea receives the maximum score. Another more recently formulated method of scoring the originality of verbal ideas is through the use of semantic networks (e.g., Acar & Runco, 2014; Dumas & Dunbar, 2014). This method uses the semantic structure of a given language to operationalize originality, and calculation through latent semantic analysis (LSA) (Dumas & Dunbar, 2014). Specifically, this involves the idea of generating the semantics farther away from the prompt, which receives a higher original score (Dumas & Dunbar, 2014). Dumas and Dunbar (2014) suggest that fluency and originality are best conceptualized as distinct but positively correlated constructs. Using LSA creates fluency and originality that are more independent from one another than previously used methods for scoring originality. Therefore, we can use the LSA method of originality in the future to replicate this study and observe whether there are different findings.

A limitation of this study is that only one method was adopted for manipulating the exercise of self-control. Using other methods that manipulate various levels of self-control may yield different results. Accordingly, future studies should consider adopting methods that manipulate various levels of self-control. Regarding the measurement of divergent and convergent thinking, only one task was employed in this study. Other tasks may yield different results. Therefore, future studies should consider varying the tasks when measuring divergent and convergent thinking to enhance the generalizability of the study results.

Regarding the application of increased divergent thinking, the results of this study indicate that before performing creative thinking, exercising self-control increases divergent thinking performance. Therefore, in the future, allowing individuals to exercise self-control before performing divergent thinking might increase their divergent thinking performance. In addition, individuals with
high gelotophobia or katagelasticism can enhance their divergent thinking to a higher degree compared with those with low gelotophobia or katagelasticism. Regarding convergent thinking, individuals with high gelotophobia exhibit enhanced convergent thinking after exercising self-control, whereas those with low gelotophobia exhibit reduced convergent thinking. Therefore, the PhoPhiKat dispositions of individuals must be considered when exercising self-control to enhance divergent and convergent thinking. In other words, it is necessary to consider the moderating effect of the PhoPhiKat dispositions of individuals.

References


