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Enhancing Verbal Creativity via Brief Interventions During an Incubation Interval

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Previous studies revealed inconsistent findings about the effects of cognitively low or high demanding interpolated tasks during incubation period on post-incubation creative performance. To explain this contradiction, two intervention tasks were administered (Reflecting on the generated ideas [RF] and the Word puzzle task [WP]), which are supposed to elicit remote associative processes but with varying levels of cognitive demands, along with two verbal control tasks (phonemic fluency task and object characteristics task). A delayed-incubation paradigm was used to assess whether performance on verbal creative problem solving (Alternative Uses Task, AUT) could be stimulated by the applied intervention tasks. The results showed that only RF and WP tasks, but not the control tasks, were associated with significant incubation effects. The findings suggest that the interpolated tasks that were assumed to elicit remote associative processes can unfold beneficial effects on verbal creative problem solving, regardless of whether the task is cognitively low or high demanding.

When do creative ideas appear? Anecdotal reports of geniuses (Ghiselin, 1985) indicated that it often happens after an incubation period (Wallas, 1926), during which the unsolved problem was put aside. The positive effect of the incubation period on later creative problem solving (e.g., generating more original answers) is commonly referred to as *incubation effect*, and has been confirmed in many previous studies (Baird et al., 2012; Beeftink, van Eerde, & Rutte, 2008; Ellwood, Pallier, Snyder, & Gallate, 2009; Gilhooly, Georgiou, & Devery, 2012; Gilhooly, Georgiou, Garrison, Reston, & Sirota, 2012; Segal, 2004; Sio & Rudowicz, 2007). There is some question as to what types of interpolated tasks in the incubation period produce larger incubation effects.

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One important factor that could influence the incubation effect may be assumed in the level of cognitive demand that the interpolated task elicits. Although some studies reported that performing high demanding interpolated tasks (e.g., mental rotation, counting backwards, visual memory tests) in the incubation period was beneficial to creative problem solving (Patrick, 1986; Segal, 2004), many other studies reported contrary findings suggesting that the engagement in low demanding tasks (e.g., reading, relaxation) in the incubation period promoted creative performance (Browne & Cruse, 1988; Elsbach & Hargadon, 2006). One meta-analysis (Sio & Ormerod, 2009), including 117 studies, came up to the preliminary conclusion that incubation effects tend to be larger in studies where individuals were engaged in low as compared to high demanding interpolated tasks or a rest task. This was supported by a recent empirical study (Baird et al., 2012), which directly compared the effects of varying cognitive demands of interploated tasks within a single experiment. Baird and colleagues demonstrated that a choice-reaction-time task (lower demanding task) in the incubation interval improved creative performance far more than did a one-back working memory task (higher demanding task) and the rest task.

Why should a low demanding interpolated task in the incubation interval be associated with positive effects on subsequent creative problem solving? According to the Explicit–Implicit Interaction (EII) model of creative thinking (Helie & Sun, 2010), incubation involves unconscious implicit associative processes that demand little attention capacity, rather than conscious, explicit, and rule-governed processes. The unconscious work account of incubation (see Dijksterhuis & Meurs, 2006; Gilhooly, Georgiou, & Devery, 2012; Gilhooly, Georgiou, Garrison, et al., 2012) suggests that activation in semantic networks during an incubation period could automatically spread to remote and relevant nodes, thereby positively affecting creative problem solving. Empirically, some studies found that low demanding tasks could facilitate greater mind wandering and prevent focusing concentration (Mason et al., 2007; Smallwood, Nind, & O'Connor, 2009), which may, in turn, stimulate remote activation in semantic networks during an incubation period, and thus improve creative performance (Baird et al., 2012; Sio & Ormerod, 2009). This leads to an exciting hypothesis: If the stimulation of remote associative processes (by interpolated tasks) would be, indeed, responsible for the incubation effect, one would expect that different interpolated tasks that stimulate remote associative processes—regardless of whether they are cognitively low or high demanding—would unfold beneficial effects on post-incubation creative performance. This hypothesis can be investigated by comparing interpolated tasks that are supposed to elicit remote associative processes, but with high versus low cognitive demands, with other tasks that are not assumed to stimulate such processes.

In this study, two interpolated verbal tasks were administered: Reflecting on the generated ideas (RF task) and a Word puzzle task (WP task). These two tasks can be assumed to stimulate remote associative processes. Reflecting on the generated ideas involves examination and intuitive evaluation of the creative output, which may elicit associative processes (Morewedge & Kahneman, 2010). A recent fMRI study (Fink et al., 2010) found that the RF task was associated with activity patterns in posterior brain regions (i.e., posterior cingulate gyrus) that are known as important components of the neural network specialized for semantic information processes (see Binder, Desai, Graves, & Conant, 2009). These findings could be interpreted in a manner that the RF task elicited the retrieval of novel associations (Fink et al., 2010). Moreover, verbal insight tasks (e.g., WP task) performance was shown to rely on remote associative processes, such as the automatic spread of activation through the semantic networks, to achieve the restructuring of problem representation (Ash & Wiley, 2006; Knoblich, Ohlsson, Haider, & Rhenius, 1999). This type of task has been observed to evoke activation of right temporo-parietal regions, especially the superior temporal gyrus that are believed to mediate coarse semantic coding, thereby facilitating remote associations (Jung-Beeman et al., 2004; Kounios et al., 2008; Sandkuhler & Bhattacharya, 2008).

Two other verbal tasks, which are not assumed to evoke remote associative processes, were selected as control tasks. One was the phonemic fluency task (PF task), which requires that participants to name as many words as possible from a single cue (e.g., beginning with a specific letter, W). Plenty of lesion studies revealed that persons with frontal lobe damage exhibit impaired phonemic fluency, and their semantic fluency remains relatively intact (Alvarez & Emory, 2006; Henry & Crawford, 2004; Reitan & Wolfson, 1994). A recent study of comparing frontal and posterior lesions patients revealed that performance in the PF task was not only sensitive but also specific to the damage of the frontal lobe that was supposed to be associated with executive control instead of semantic processes (Robinson, Shallice, Bozzali, & Cipolotti, 2012). The other control task was the object characteristic task (OC task), which requires participants to retrieve typical characteristics of conventional objects (such as shoes or a coat hook). The OC task is a relatively convergent task and has been shown to evoke activation in regions of the right inferior parietal cortex (around angular gyrus), possibly reflecting the retrieval of prevalent, typical, or directly stimulus-related information during the performance of this task (Binder et al., 2009; Fink et al., 2009; Fink et al., 2010; Fink et al., 2012).

The effects of the four mentioned interpolated tasks on verbal creative problem solving were assessed by means of a delayed-incubation paradigm (Dodds, Ward, & Smith, 2012; Gilhooly et al., 2012). Participants worked on a target task, performed different interpolated tasks during the incubation period, and resumed working on the target task after incubation. The target task in this study was the Alternative Uses Task (AUT; Guilford, 1967), which is one of the most widely used tools to measure creativity (Kaufman, Plucker, & Baer, 2008), and is considered as reliable and valid indicator of creative potential (Runco & Acar, 2012). In the AUT, participants were instructed to generate as many unusual or original uses for commonly used objects as possible, such as comb (an instrument, a wind-bell) or paperclip (making a ring, cleaning fingernails). Furthermore, in considering the fact that affective factors may also influence creative cognition (see Baas, De Dreu, & Nijstad, 2008; Davis, 2009), participants' state anxiety, mood, and various emotions were assessed prior to the experiment, to determine whether these factors have impacts on incubation effects. The main hypothesis of this study is that both the RF task and the WP task (irrespective of their levels of cognitive demand) will be associated with stronger incubation effects (i.e., improvements of creative performance after the incubation period compared to the period before) than the PF task and the OC task, given that the former two tasks were found as being likely to elicit remote semantic activation and the formation of remote associations in previous research.

METHOD

Participants

Thirty-seven healthy undergraduates (18 men, 19 women; range from 17 to 25 years of age, $M = 19.89$, $SD = 2.17$) participated individually in the study. They gave written informed consent before the experiment, and got paid for their participation after the experiment.

Procedure

A within-subject design was adopted in this study. In total, a participant was presented 80 AUT problems. He or she solved 20 AUT problems in each of the four experimental conditions (i.e., RF, WP, PF, and OC incubation conditions); the 20 AUT problems within one condition were arranged in a random sequence for every participant. The sequences of experimental conditions were balanced for all participants following a Latin square. The duration of solving the AUT problem, performing the interpolated task, and resuming working on the same AUT problem was 69 sec for each trial (see Figure 1). Specifically, similar to previous studies (Fink et al., 2012; Fink, Schwab, & Papousek, 2011), participant was first asked to (mentally) generate ideas for unconventional uses of a presented item within a time period of 15 sec, with no overt response allowed. In the next 3 sec, he or she was instructed to report only the most original idea they had generated. The period of idea generation and the subsequent response were named as Stage 1. During the next incubation period of 28 sec, participants were asked to work on the interpolated tasks.

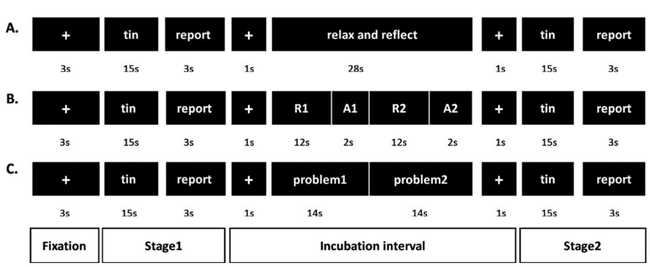

FIGURE 1 (A) and (B) Illustrate Experimental Paradigms of RF and WP Incubation Conditions, Respectively. "R1"and "R2" Means Riddles, "A1" and "A2" Means Answers. (C) Illustrates Experimental Paradigm of OC and PF Incubation Conditions.

In the RF incubation condition (see Figure 1 A), participant should relax and reflect on the ideas he or she just generated in Stage 1. In the WP incubation condition (see Figure 1B), participant was asked to guess two Chinese logogriphs, chosen from a Chinese Word Puzzles Database (Wu, Qiu, & Zhang, 2008). For each logogriph, the riddle (normally by 3–6 Chinese characters) was presented for 12 sec, and the correct answer (i.e., one Chinese character) to the riddle was presented for the following 2 sec, irrespective of whether participant reported it or not. Forty different logogriphs were used in the 20 test trials.

In the PF incubation condition (see Figure 1 C), participant was presented two Chinese characters, chosen from the "Chinese Characters Word-formation Capacity Analysis Sheet" of the "Modern Chinese Frequency Dictionary" (ILTSBLC, 1986). For each presented character, participant used it as the beginning character to make a Chinese word and reported as many words of this type as possible within 14 sec. For the 20 trials in the WP incubation, 40 Chinese characters were used. The frequencies of these characters vary from 50 to 90, which mean that they are frequently used and that it is easy to build words with them.

In the OC incubation condition (also see Figure 1 C), two objects (e.g., icebox, basketball) were presented, whose names were all composed by two Chinese characters. For each presented object, participant needed to report as many typical characteristics as possible within 14 sec. For the 20 trials in the OC condition, 40 objects were selected. These objects did not overlap with the conventional everyday objects used in the AUT.

Upon finishing the interpolated task in the incubation period, participant resumed working on the same AUT problem (Stage 2). In both stages, participant's oral responses for the presented AUT problems were recorded and afterwards transcribed for further analysis.

Pre- and Postexperiment Measures

Prior to the experiment, participant's state anxiety was measured by means of a Chinese version of Spielberger's state-trait anxiety inventory (STAI; Li & Qian, 1995; Cronbach's alpha = .85 in this study). In addition, participant's current mood was assessed by the item of "How do you feel right now?" on a scale ranging from 1 (*very bad*) to 9 (*very good*). And finally, various emotions were assessed by asking how "worried," "disappointed," "calm," "happy," "content," "tense," "discouraged," and "relaxed" the participant currently felt on a scale ranging from 1 (*not in the least*) to 9 (*being in the highest*; see Friedman & Förster, 2000, 2002).

Immediately after the participant finished the experiment, he or she was asked to rate the level of mental effort in performing each of four interpolated tasks on a 9-point scale ranging from 1 (*extremely low*) to 9 (*extremely high*). Such a technique (i.e., self-reported mental effort ratings) is a widely used method to measure the level of cognitive demand of a task, which has been proven to be most sensitive to reflect the cognitive demand of intrinsic processing elicited by the task, relative to another two techniques for measuring cognitive demand (i.e., response time to a secondary task during task performance, and difficulty ratings of task; Ayres, 2006; DeLeeuw & Mayer, 2008; Paas, Tuovinen, Tabbers, & van Gerven, 2003).

Assessment of Performance on AUT Problems and Engagement in Interpolated Tasks

One of the frequently used procedures to quantify the performance of creative idea generation is the subjective scoring method (see De Dreu, Nijstad, Baas, Wolsink, & Roskes, 2012; Gilhooly, Georgiou, & Devery, 2012; Gilhooly, Georgiou, Garrison, et al., 2012; Silvia, 2011). Admittedly, there are clear limitations to this method due to its subjective nature, especially the *rater bias*. Specifically, people have greater difficulty in evaluating highly original ideas than less original ideas (Runco & Chand, 1994; Runco & Smith, 1992; Runco & Vega, 1990), and many people probably have a disdain for original and risky ideas, perhaps due to an aversion to ideas that are inconsistent with societal norms and mores (Blair & Mumford, 2007). However, subjective scoring method embodies the idea that "creativity is assessed in the real world" and subjective ratings are generally stable across time (Kaufman et al., 2008, p. 55). In addition, utilizing objective and subjective methods to assess the originality of creative ideas could yield nearly identical results (Baird et al., 2012). Thus, subjective scoring procedures could be considered as useful, alternative scoring strategies to assess performance of creative idea generation, besides objective scoring methods (e.g., uniqueness scoring method; Guilford, 1967; Runco, 1999; Wallach & Kogan; 1965).

In thise current study, the subjective scoring method was used to assess performance in the AUT: (a) Six raters independently evaluated the originality for each idea reported by the participants on a 5-point Likert scale (1 = *not original at all*, 5 = *highly original*). Internal consistency of the ratings (Cronbach's alpha coefficient = .88) was satisfactory. (b) The ratings for each single idea from 6 raters were averaged into one originality score for each idea. Accordingly, each participant got 20 or less (because of trials with no response) scores respectively in stage 1 or in stage 2 for each condition (note that the mean rates of trials with responses in each stage under each condition for each participant ranged from 94.5% to 98.5%. The repeated measures ANOVA revealed no significant effect of Stage or Condition on the response rates.) (c) Each participant's mean originality scores in Stage 1 or Stage 2 under one of the four conditions were calculated by means of the following equation. Here, *n* indicated the number of responses; *Oi* means the originality score of one response (i.e., an idea).

$$Originality = \frac{\sum_{i=1}^{n} O_i}{n}$$

Finally, for each participant, eight mean originality scores (two stages × four conditions) were available. These scores were used to explore the effects of condition and stage on creative performance.

Various methods were utilized to assess whether participants were cognitively engaged in the four interpolated tasks during the incubation intervals. For the RF task, participants were instructed to evaluate their cognitive engagement on a 5-point scale ranging from 1 (*not at all*) to 5 (*very much*) immediately after they finished the trials in the RF condition. If their self-rated scores were significantly higher than the mean score of random choice (i.e., 3) that would be expected by participants randomly selecting one of the five ratings, it could be taken as indication that they were, indeed, cognitively engaged in the RF task. For the WP task, participants' mean accuracy rates on each of 40 logographs were calculated. If they were not different from the data of the comparison sample (provided by Chinese Word Puzzles Database; Wu et al., 2008), it could be concluded that participants were actually engaged in the WP task. For the PF and OC tasks, the mean numbers of generated ideas for the PF or OC problems for every participant were calculated. A control group of subjects ($N = 35$, 16 men, 19 women; range from 18 to 25 years of age, $M = 20.53$, $SD = 1.98$) was arranged to work on the same PF and OC tasks without being in the context of incubation. If the numbers of generated ideas on the PF and OC tasks for the experimental group were not different from those of the control group, it would suggest that participants were actively engaged in the PF and OC tasks in the incubation interval.

RESULTS

Cognitive Engagement in the Interpolated Tasks

Participants' self-reports of engagement in the RF task ($M = 3.3$, $SE = .17$) was significantly higher than the mean score of random choice (i.e., 3; one-sample *t*-test, test value is 3), $t(36) = 2.96$, $p < .01$. This means that participants were likely to be actually involved in RF task performance. In the WP task, participants' mean accuracy rates on each of 40 logogriphs ($M = .18$, $SD = .09$) were not significantly different from the data of the comparison sample ($M=.2$, $SD=.06$; Wu et al., 2008), $t(39)=1.15$, $p>.05$. This result suggests that participants were engaged in performing the WP task. Moreover, participants generated plenty of ideas for each problem of the PF task ($M=4.06$, $SD=.66$) and the OC task ($M=3.44$, $SD=.68$). These could be considered as good task performance, given that the time period was only 14 sec. Also, such performance did not differ significantly from that of the control group on the PF task ($M=3.97$, $SD=.54$), $t(70)=.61$, $p>.05$, and the OC task ($M=3.2$, $SD=.51$), $t(70)=1.67$, $p>.05$. These results demonstrate that participants were engaged in the PF and the OC tasks during the incubation intervals. Taken together, these findings indicate that participants were engaged in the four interpolated tasks.

Incubation Effects

A repeated-measures ANOVA with stage (stage 1 and stage 2) and condition (RF, WP, PF, OC) as within-subject factors was performed on the mean originality scores of the AUT problems. There was a significant main effect for Stage, $F(1, 36)=23.08$, $p<.001$, $\eta_p^2=.39$, but not for condition. More interestingly, there was a significant interaction effect of stage×condition, $F(3, 108)=15.96$, $p<.001$, $\eta_p^2=.31$. Specifically, in stage 1, the originality scores in four conditions were not significantly different from each other, $F(3, 108)=1.85$, $p=.14$, $\eta_p^2=.03$. In stage 2, however, the originality scores in the four conditions displayed a significant difference, $F(3, 108)=5.5$, $p<.001$, $\eta_p^2=.1$. Post-hoc LSD tests revealed that, in stage 2, the scores in the RF condition were significantly higher than those in the OC and PF conditions ($p<.001$ and $p<.01$, respectively), but were not significantly different from those in the WP condition ($p=.44$). Moreover, the scores in the WP condition were significantly higher than those in the OC and PF conditions ($p<.01$ and $p<.05$ respectively; see Figure 2). These results demonstrate that the incubation intervals with the RF and WP tasks were associated with higher scores in post-incubation AUT performance than the remaining tasks.

To explore whether the changes (i.e., increase or decrease) of creative performance between stage 1 and stage 2 were significantly different among the four experimental conditions, an improvement index was calculated (performance in stage 2 relative to that in stage 1) for each of the 80 AUT problems, similar to previous research (Baird et al., 2012). The repeated measures ANOVA yielded a significant main effect of incubation condition, $F(3, 108)=11.57$, $p<.001$, $\eta_p^2=.24$. Post-hoc LSD tests revealed that the improvement in the RF condition was significant greater than that in the WP, OC, and PF conditions ($p<.05$, $p<.001$, $p<.001$, respectively).

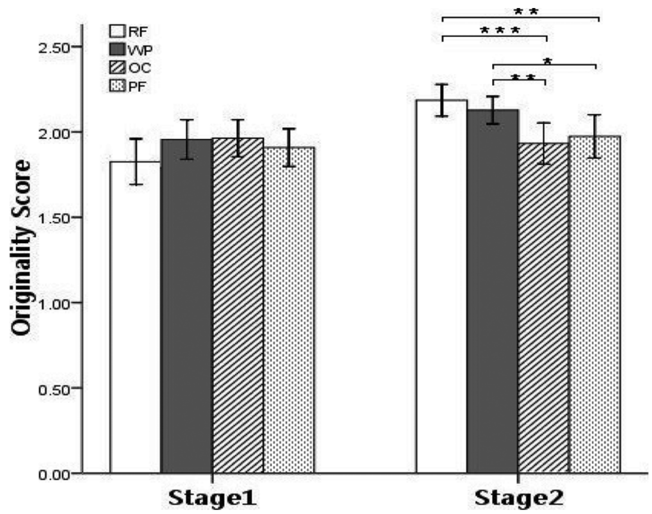

FIGURE 2 Alternative Uses Task (AUT) Originality Scores in the Pre- (Stage 1) and the Post-incubation Period (Stage 2) Separately for the Four Incubation Conditions. Error Bars Indicate Standard Errors of the Mean.

The improvement in the WP condition was significantly higher than that in the OC condition ($p<.05$), but not compared to the PF condition ($p=.12$; see Figure 3). These results also indicate that the incubation intervals with the RF and WP tasks have more positive impacts on performance improvement than the remaining tasks.

To further test whether different incubation conditions improve the creative performance from stage 1 to stage 2, the performance between two stages were compared separately for every condition. Paired-samples t-tests showed that for the RF condition, the scores in stage 2 were significantly higher than those in stage 1 ($M=2.19$ vs. $M=1.79$), $t(36)=7.93$, $p<.001$, $d=1.28$. Similar phenomenon emerged in the WP condition

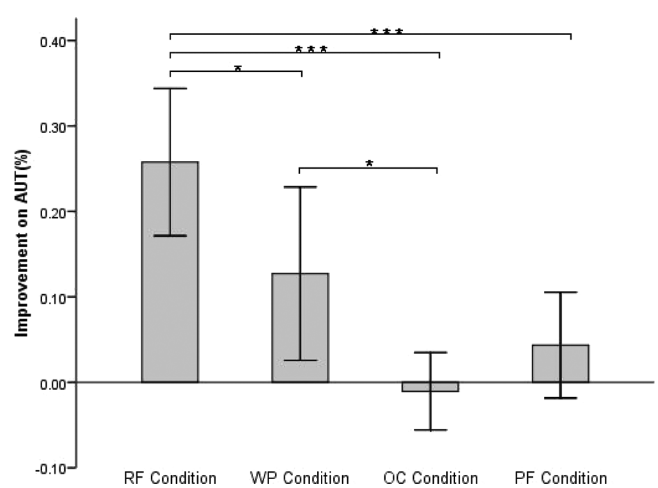

FIGURE 3 Improvement in Alternative Uses Task (AUT) Originality Scores (Performance in Stage 2 Relative to Stage 1). Error Bars Indicate Standard Errors of the Mean.

(stage 2: $M=2.13$ vs. stage 1: $M=1.96$), $t(36)=3.07$, $p<.01$, $d=.57$. However, in the PF and the OC condition, the originality scores in two stages were not significantly different from each other ($ps>.05$). These results reveal significant incubation effects (i.e., improvements of creative performance from stage 1 to stage 2) only in the RF and WP, but not in the PF and OC conditions.

Levels of Cognitive Demands of the Interpolated Tasks

Another repeated measures ANOVA revealed that the levels of cognitive demands of the four interpolated tasks were significantly different, $F(3, 108)=15.56$, $p<.001$, $\eta_p^2=.3$. Post-hoc LSD tests revealed that the level of the RF task was significantly lower than that of the WP, OC, and PF tasks ($p<.001$, $p<.001$, $p<.01$, respectively). Moreover, the level of the WP task was significantly higher than that of the PF or OC task ($ps<0.01$).The levels of PF task and OC task were not significantly different from each other ($p=0.62$). These results provide evidence that those interpolated tasks that contributed to the incubation effect were, on the one hand, of the lowest level of cognitive demand (i.e., RF task) and, on the other hand, of the highest level (i.e., WP task; see Figure 4).

Effects of Other Factors on the Originality Scores

The self-reported scores for state anxiety, mood, as well as various emotions, displayed no correlation with the originality scores in the two stages. Furthermore, none of these variables diminished the effects of condition (RF, WP, PF, OC) on the mean originality scores after each of these factors was entered into the ANOVA model as a covariate.

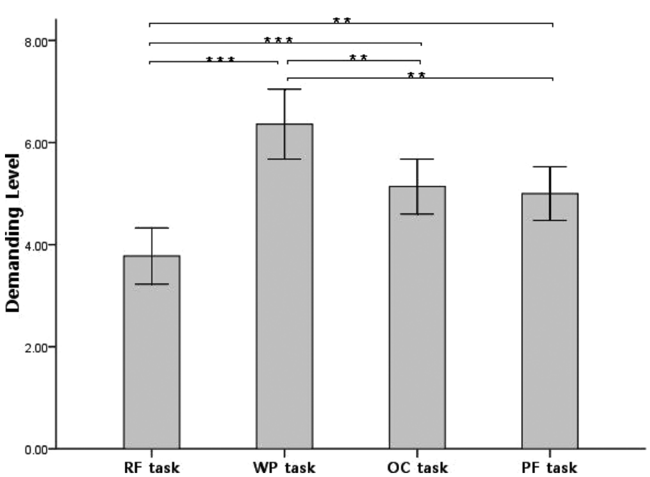

FIGURE 4 Demanding Levels (as Determined by Self-Report) of the Four Interpolated Tasks. Error Bars Indicate Standard Errors of the Mean.

DISCUSSION

Previous studies in this field revealed that cognitively low demanding interpolated tasks in the incubation interval promoted subsequent creative performance (see Baird et al., 2012; Sio & Ormerod, 2009). This result was replicated in this study where the RF task with the lowest level of cognitive demand had the most pronounced incubation effect on AUT performance (see Figure 3). Furthermore, the interpolated WP task, which had the highest level of cognitive demand (see Figure 4), unfolded beneficial effects on AUT performance as well (see Figure 2 and Figure 3). This is the first study that demonstrated that both tasks of low and high levels of cognitive demands exhibited larger incubation effects on verbal creative performance than did medium demanding tasks (see Figure 4).

These results provide strong evidence in favor of our main hypothesis. That is, the interpolated tasks that are thought of as stimulating remote associative processes (e.g., RF and WP tasks), as compared to the tasks that do not activate such processes (e.g., PF and OC tasks), have beneficial effects on post-incubation verbal creative thinking. The findings could be interpreted in a manner that performing RF and WP tasks in the incubation intervals may promote the activation in semantic networks to automatically spread to remote and relevant nodes, which in turn, based on the unconscious work hypothesis (see Dijksterhuis & Meurs, 2006; Gilhooly, Georgiou, & Devery, 2012; Gilhooly, Georgiou, Garrison, et al., 2012), has a positive impact on subsequent creative problem solving. In addition, the results again emphasize the beneficial effects of a low demanding interpolated task. As depicted in Figure 3, the RF task actually elicited a significantly larger incubation effect than the WP task. This may be because reflecting on the own ideas may not only elicit semantic associations (Fink et al., 2010), but also permit greater mind wandering due to its low demanding level, which strengthens associative processes (Baird et al., 2012). Our findings thus suggest that an interpolated task evoking remote associative processes with a comparatively low level of cognitive demand might have the most beneficial effect on the subsequent generation of ideas.

It should be noted, however, that there are other theories besides the unconscious work theory, which may account for the incubation effect. The fatigue recovery theory suggests that the incubation interval is a cognitive respite period, which allows reduction of mental fatigue and rejuvenation of the problem-solving skills (see Dodds et al., 2012; Helie & Sun, 2010). The observation that the RF task brought about stronger incubation effects seems to be explained by this theory, given that the RF task could be considered as the most relaxing task in all four interpolated tasks. But such a theory could not explain why the WP task, the most exhausting task as participants indicated, also produced a significant incubation effect. Thus, the findings are not completely in line with the proposed fatigue recovery mechanism of the incubation effect. Another assumption, called intermittent conscious work (Seifert, Meyer, Davidson, Patalano, & Yaniv, 1995; Weisberg, 2006), proposes that participants may carry out intermittent conscious work in the incubation interval and then improve performance when the target problem was readdressed. It is suggested that any conscious work during the incubation interval would impair performance on the interpolated task, as a result, as a check against the possibility of intermittent conscious work, performance on the interpolated task during the incubation interval should be compared with the performance of a control group working on the same interpolated task without being in an incubation condition (Gilhooly, Georgiou, Garrison, et al., 2012). In our study, the results did reveal that participants' performance on the interpolated tasks of WP, OC and PF were not different from the data of a comparison sample and that of a control group. Thus, it seems that our results do not lend support to the theory of intermittent conscious work. However, it must be pointed out that our results cannot confirm or refute the beneficial forgetting theory of the incubation effect, which suggests that an incubation interval weakens the activation of old inappropriate solutions and then allows a fresh view of the problem (Penaloza & Calvillo, 2012; Smith & Blankenship, 1991).

There were also limitations of this study. First, participants' engagement in the RF task could not be objectively measured. However, their self-reports of engagement indicated that they were actually involved in the RF task during the incubation interval. Second, to control an extra variable, viz. dissimilarity or similarity between the interpolated task and the target task (see Dijksterhuis & Meurs, 2006; Gilhooly, Georgiou, & Devery, 2012), four tasks with the similar main modality (i.e., verbal) were selected as interpolated tasks. The findings can thus not be generalized to the performance of other types of interpolated tasks (e.g., spatial tasks). Third, the results on verbal creative performance (i.e., the AUT problems) can neither be generalized to the domain of visual creativity (e.g., nine-dot problem), because any differences between visual and verbal problems may arise through a greater reliance on strategic search, rather than knowledge activation in the former than in the latter (Sio & Ormerod, 2009). Finally, there are more objective and widely used methods for scoring divergent thinking tests, including the AUT (Guilford, 1967; Runco, 1999; Wallach & Kogan; 1965). The method used herein was subjective and reliable, at least in the sense of interjudge agreement, but findings should be replicated with more objective methods for scoring the AUT.

In conclusion, the findings of this study suggest that verbal creative thinking can be promoted via a brief intervention break in which remote associative processes are elicited by certain verbal tasks, regardless of how cognitively demanding they are. The analysis of cognitive engagement indicated that the participants actively worked on the interpolated tasks in the incubation intervals. Traditionally, an interpolated task in the incubation interval was regarded as *distractive task* (Ellwood et al., 2009; Jett & George, 2003), usually employed to make attention shifting away from the current problem. Interpolated task could be likewise regarded as intervention task, intentionally selected to promote creative problem solving. From a theoretical perspective, these findings support the unconscious work theory rather than the fatigue recovery theory or the intermittent conscious work theory of the incubation effect.

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