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Examples facilitate divergent thinking: The effects of timing and quality

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ABSTRACT

The study investigated the effects of examples' timing and quality on divergent thinking (DT). In study 1, participants received two novel or common examples in the early or late stage of the realistic presented problem task. Results revealed higher fluency and flexibility in the late stage than that in the early stage. Moreover, originality was higher in the novel-example condition than that in the common-example condition. In study 2, participants solved alternative uses task (AUT) and received examples as in study 1. Results replicated beneficial effects of timing and quality on DT in study 1. Furthermore, in the late stage, fluency and flexibility were higher in the novel-example condition than that in the common one. These findings indicate that timing and quality affect example effect on DT, with late or novel examples facilitating DT. More importantly, in AUT, examples quality moderates the role of timing in DT's fluency and flexibility.

1. Introduction

Creativity is defined as the ability to generate novel and useful ideas, insights, or problem solutions (Amabile, 1983; Sternberg & Lubart, 1999). When engaging in creative work, people usually turn to the Internet or books to seek inspiration. Previous studies have revealed hints or cues could improve creative performance. For example, strategy instructions before tasks could enhance creativity performance in figural divergent thinking (Forthmann, Wilken, Doebler, & Holling, 2016). Findings of Liu (2016) indicate that tasks inducing conceptual attention before divergent thinking could facilitate creativity performance. More importantly, researchers have found that exposing individuals to examples can effectively facilitate creative idea generation (Vasconcelos & Crilly, 2016; Pi, Hong, & Hu, 2019).

However, findings regarding when the examples should be presented are inconsistent. While some researchers have argued that it is more effective to present examples before the task than during the task (Sio, Kotovsky, & Cagan, 2015), others have reached the opposite conclusion (Siangliulue, Chan, Gajos, & Dow, 2015; Tseng, Moss, Cagan, & Kotovsky, 2008). Except for the question of "WHEN", the question of "WHAT" also remains under debate. One previous study has found that the analogical similarity between the target task and examples modulates examples' timing effect. Surface similar examples lead to better product design performance when

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presented at the beginning of the task, while surface dissimilar examples facilitate product design more when presented during design task (Tseng et al., 2008). It must be noted that, factors that may modulate examples' timing effect was only examined in design study, little is investigated in verbal divergent thinking. Moreover, the possible modulating factors are limited to analogical similarity between target and examples. According to the associative theory, novel ideas often come from distant concepts' combination. Therefore, both novelty of examples and analogical similarity associate with semantic distance (Liu et al., 2021; Kenett, 2019). It is possible that the timing's effect on creative ideation can be affected by the novelty of examples. Therefore, the current study aimed to explore the effect of examples' quality (i.e., novelty) and timing on verbal divergent thinking.

1.1. The temporal pattern of divergent thinking

As a key facet of creativity, divergent thinking (DT) has been demonstrated to be a reliable predictor of creative potential (Runco & Acar, 2012). The temporal pattern (i.e. the serial order effect) is one of DT's important characteristics. That is, when the idea quality goes up, the idea quantity goes down as the task proceeds (Christensen, Guilford, & Wilson, 1957).

According to the classic associative model of creativity, DT is a process of spreading activation in semantic memory (Mednick, 1962). It takes time to reach distant concepts than the near ones. Ideas generated later are more novel because creative ideas result from the activation and connection of distant concepts (Kenett, 2019). Controlled attention theory further suggested that executive processes such as strategic retrieval and manipulation of knowledge contributed to the concept's connection during idea generation (Kleinkorres, Forthmann, & Holling, 2021; Pan & Yu, 2016; Wang et al., 2017)). More recently, by a series of response time analyses, researchers have emphasized the serial order effect's mechanism within modern theories of semantic memory search (Hass, 2017; Hass & Beaty, 2018).

1.2. The role of examples' timing in creativity

Because of the dynamic process of DT, the role of example's timing in creative problem-solving (e.g. design task) has been widely investigated. However, studies are confined to design field of which findings are controversial. While some studies have found that examples presented at the beginning boost DT more than those presented during the work, others have demonstrated that examples are more effective when presented after a period of initial work than at the beginning of work (Moss, Kotovsky, & Cagan, 2011; Perttula & Liikkanen, 2006; Sio et al., 2015). Some even argued that it's more appropriate to present examples when there's a deadlock (Siangliulue et al., 2015).

Different explanations have been proposed to account for this timing effect. According to the spreading activation explanation, the initial problem space expands after a period of work, and this will shorten the semantic distance between examples and target problem (Kenett, 2019). This makes it easier for individuals to make good use of examples. Others proposed an "open goal" account. Inspirational stimuli would be more effectively applied if an open goal has been established (Tseng et al., 2008). However, according to the account of sunk cost effect, the longer an individual works on a problem, the less likely he/she change the applied problem solving method (Viswanathan & Linsey, 2013). Likewise, after a period of work, individuals may be content with staying where he/she is rather than make use of external cues (e.g. examples).

Note that although effects of examples' timing on design have been investigated, its effects on verbal divergent thinking (a more general domain) still remains unclear. It is also unclear whether examples presented before or during the verbal divergent thinking are more effective.

1.3. The role of examples' novelty in timing effect

Examples' timing effect may depend on the quality or quantity of examples. For instance, examples similar to the target problem are more impactful than those dissimilar ones, when presented at the beginning of problem solving (Tseng et al., 2008). Besides, if examples are distantly related to the design problem, presenting them after a period of initial work is more impactful than presenting them before problem solving (Tseng et al., 2008). Although effects of the example novelty on creative ideation has been investigated a lot, whether it functions differently at different stages during DT is less investigated (Agogué et al., 2014; Berg, 2014; Dugosh & Paulus, 2005; Matuk & Linn, 2018; Wang & Nickerson, 2019).

According to DT's serial order effect, ideas that arise later are more original (or less common) than those earlier. The later ideas arise, the more distant concepts from semantic memory are combined. This temporal pattern indicated that novelty of idea is relevant to its timing. Therefore, it reasonable to explore the role of examples' novelty in the timing's effect.

1.4. The current study

Taken together, example's timing affects creative ideation. Its effects were widely investigated in the field of design (domain-specific creativity), but not yet explored in the field of verbal divergent thinking (domain-general creativity). Moreover, the interaction effect between example timing and novelty on DT is yet unknown.

To address these two questions, two studies with a 2 (Timing: early vs. late) × 2 (Quality: common vs. novel) between-subject design were conducted. The participants in Study 1 and Study 2 were asked to complete one 5-min realistic presented problem (RPP) and one 5-min alternative uses task (AUT), respectively. They received two novel or common examples in the *early* or *late* condition. According to the "open goal" explanation, presenting cues during problem solving when individuals have developed a

problem-solving goal would be more effective. Therefore, we proposed hypothesis 1: verbal DT performance (i.e. fluency, originality and flexibility) is better when examples are presented in the late condition than that in the early condition. Besides, the spreading activation explanation has revealed that individuals can reach distant and rare concepts in the late stage of task as their problem space become expansive after a period of time. It is possible novel cues can be more easily recognized during the task instead of before the task. Therefore, examples could be used to generate more ideas and more original ideas. Accordingly, we proposed hypothesis 2: in the late task stage, verbal DT performance (i.e. fluency, originality and flexibility) is better in the novel group than in the common group.

2. Study 1

Study 1 investigated the effect of examples' timing and novelty on verbal DT. Previous studies have demonstrated that realistic problems are more interesting than other DT tasks because they have a connection to reality and natural environment (Okuda, Runco, & Berger, 1991). Therefore, this task has high ecological validity. Accordingly, RPP was used to assess DT. Participants were asked to generate as many original solutions as possible in 5 min (Xue, Lu, & Hao, 2018). Common or novel examples were presented to the participants at the beginning or in the late stage of the task.

2.1. Participants and design

A priori power analysis using G*power 3.1 (Faul, Erdfelder, & Lang, 2007) was conducted to estimate the sample size necessary for main effects and interactions at 80% power. The between participants effect size was set to $\eta^2 = 0.25$. According to the results, the required sample size is 196. We recruited 240 participants online. A 2 (Timing: early vs. late) × 2 (Quality: common vs. novel) between-subject design was employed. In addition, the experiment set a control group where no examples were presented. Participants were randomly assigned to one of the five experimental groups.

Among the 240 participants, 35 were excluded because they failed to complete all items during the experiment. Thus, the final sample consisted of 205 participants (157 females, 48 males; age: 21.11 ± 4.40 years old). There were respectively 40, 45, 41, 38 and 41 participants in the early-common, early-novel, late-common, late-novel and control groups (As Pearson Chi-square test showed difference in gender ratios among the five experimental groups, $\chi^2 = 19.73$, $p = 0.001 < 0.05$, the complementary analysis using gender as a covariate was presented in the results section). All participants were right-handed and native speakers of Chinese. They gave written informed consent prior to the experiment and received approximately 5 US dollars for their participation. The experiment protocol was approved by the Institutional Ethics Committee of the University.

2.2. Procedure

Participants completed this online experiment through WenJuanXing (https://www.wjx.cn). After reading the informed consent, they were randomly assigned to one of the five experimental groups. In the early-common or early-novel group, participants received two common or novel examples in the form of text for one minute at the beginning of the 5-min RPP task. In the late-common or late-novel group, participants received two common or novel examples in the form of text for one minute in the fourth minute of the task. During the task, participants were asked to generate as many and novel ideas as possible and type them into the computer.

2.3. Creativity task and assessment

RPP is a typical task to measure creative ideation (Agnoli, Corazza, & Runco, 2016; Hao, Xue, Yuan, Wang, & Runco, 2017; Runco, Abdulla, Paek, Aljasim, & Alsuwaidi, 2016). During the task, participants were asked to produce as many and novel solutions as possible to solve the given open-ended realistic problem. The realistic problem used in this study was as follows:

> "*Your friend Pat sits next to you in class. Pat really likes to talk to you and often bothers you while you are doing your work. Sometimes he distracts you and you miss an important part of the lecture, and many times you don't finish your work because he is bothering you. What should you do? How would you solve this problem? Remember to list as many ideas and solutions as you can.*"

The examples used in study 1 were obtained from the original data of a prior research (Lu, Qiao, & Hao, 2019). According to the consensus assessment technique (CAT) on a 5-point Likert scale, ideas scoring above 3 were selected as high original examples, while those scoring under 3 were selected as common examples. Specifically, the novel examples were "*pretend to have a toothache and unable to speak*" and "*tell his girlfriend about this behavior*" while the common ones were "*talk with him together*" and "punch him".

Performance of RPP was evaluated in terms of fluency, originality and flexibility (Guilford, 1967; Runco & Pritzker, 1999). Fluency was measured as the number of non-redundant ideas that were produced by the participants. For originality, six raters independently scored each idea using a 5-point Likert scale (1 = unoriginal, 5 = original). The inter-rater reliability of this method was satisfactory ($\alpha = 0.89$). For flexibility, three raters independently rated the total number of categories to which the reported responses belong for each participant. The inter-rater reliability of this method was also satisfactory ($\alpha = 0.95$). The final originality and flexibility scores for each participant were obtained by averaging the individual ratings from the raters.

2.4. Pre-experiment test

Prior to the experiment, participants were asked to complete the Creativity Tendency Scale (CTS) of Creativity Assessment Packet

(CPA),in which they selected one of three ratings (1 = totally non-fit, 2 = partly fit; 3 = totally fit) for each of the 50 items (Hou, 2019). Two example items from CTS are: "*I am always crazy about exploring the truth of things*" and "*I don't like too many rules*".

2.5. Results

2.5.1. The effects of timing and quality on creative ideation

A two-way MANOVA with Timing (early vs. late) and Quality (common vs. novel) as the between-subject factors was performed on fluency, originality and flexibility. *Box's M* = 82.40, $p < 0.05$. The results showed that the covariance matrices of these dependent variables were not homogeneous, thereby the data did not fit MANOVA. Thus, a series of ANOVAs using Timing and Quality as between-subject factors were conducted on fluency, originality and flexibility.

For fluency, a significant main effect of Timing was observed, $F(1, 160) = 27.30$, $p < 0.001$, $\eta_p^2 = 0.15$. Participants in the late-stage group had higher fluency ($M = 4.04$, $SD = 1.71$) than those in the early-stage group ($M = 2.67$, $SD = 1.75$, $p < 0.001$, Cohens' d = 0.79). No main effect of Quality and interaction effect between Timing and Quality on fluency were observed, $F(1, 160) = 3.63$, $p = 0.058$; $F(1, 160) = 2.02$, $p = 0.157$ (see Fig. 1).

With regard to originality, there was a significant main effect of Quality on originality, $F(1, 160) = 24.85$, $p < 0.001$, $\eta_p^2 = 0.13$. Results revealed higher originality in novel example group ($M = 2.35$, $SD = 0.71$) than that in the common example group ($M = 1.88$, $SD = 0.47$, $p < 0.001$, Cohens' d = 0.78). No significant main effect of Timing and interaction effect between Timing and Quality on originality were observed, $F(1, 160) = 0.42$, $p = 0.52$; $F(1, 160) = 0.35$, $p = 0.56$ (see Fig. 1).

With respect to flexibility, a significant main effect of Timing was found, $F(1, 160) = 100.50$, $p < 0.001$, $\eta_p^2 = 0.39$. Results showed that participants in the late-stage group had higher flexibility ($M = 3.25$, $SD = 1.18$) than those in the early-stage group ($M = 1.68$, $SD = 0.82$, $p < 0.001$, Cohens' d = 1.55). No significant main effect of Quality or interaction effects between Timing and Quality was found, $F(1, 160) = 2.20$, $p = 0.14$; $F(1, 160) = 0.16$, $p = 0.69$ (see Fig. 1).

To exclude the potential contaminative effect of individual differences in creativity, participants' scores on the CTS were treated as a covariate. The results showed the MANOVA' results remained significant. As the gender ratios varied across the five conditions, we also took gender as a covariate in the above MANOVA. The results showed that the effects of Timing and Quality on originality, fluency and flexibility were not affected by gender.

2.5.2. Examples' effect on creative ideation

To examine examples' facilitating effect on RPP performance, a one-way MANOVA with Example (example groups vs. control group) as the between-subject factor was conducted on fluency, originality and flexibility. *Box's M* = 100.09, $p < 0.05$. The results showed that the covariance matrices of these dependent variables were not homogeneous, thereby the data did not fit MANOVA. Thus, a series of ANOVAs using Example as the between-subject factor were conducted on fluency, originality and flexibility. Results showed that Example exerted significant main effects on fluency [$F(4, 200) = 8.92$, $p < 0.001$, $\eta_p^2 = 0.15$], originality [$F(4, 200) = 7.78$, $p < 0.001$, $\eta_p^2 = 0.14$], and flexibility [$F(4, 200) = 31.95$, $p < 0.001$, $\eta_p^2 = 0.39$].

Participants in the example groups including the late-common and late-novel groups, had higher fluency than the control group. However, participants in the early-common group had lower fluency than the control group. For originality, participants in the early-novel groups had higher originality than those in the control group. In addition, participants in the late-common, and late-novel groups showed higher flexibility than those in the control group (see Table 1).

2.6. Interim discussion

These results partially supported Hypothesis 1 that presenting examples in the late stage of task is more beneficial to DT's fluency and flexibility than presenting them in the early stage of task. These results suggest that examples become more accessible with time passing by, which lead to more ideas and more categories of ideas. However, effect of timing was not found in originality. According to associative theory of creativity (Mednick, 1962), ideas generated later are more original because of more remote concepts were retrieved and combined. In this study, whether examples presented early or late, originality increases in the late stage. Therefore, no difference of originality between these two timing conditions may be affected by the serial order effect.

Although participants in the novel-example group performed better than those in the common-example group, examples' novelty

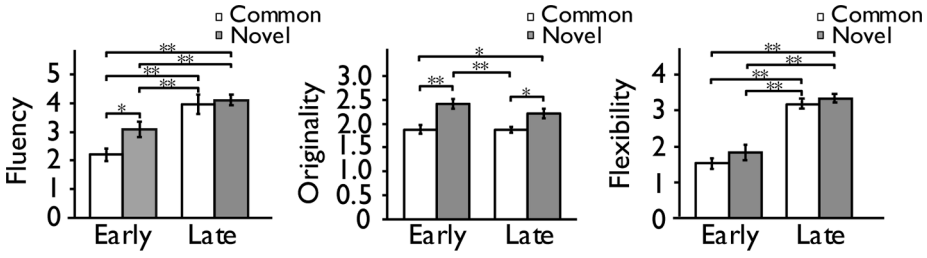

Fig. 1. Responses of Fluency, Originality and Flexibility in early-common, early-novel, late-common and late-novel groups (RPP). Error bars indicate standard errors of the mean. $^{*}p < 0.05$; $^{**}p < 0.01$.

Table 1
RPP fluency, originality and flexibility among experimental groups in study 1.

Dependent variables	Group	Scores ($M \pm SD$)	(Example vs Control)	p
Fluency (Control: 2.98 ± 1.42)	Early-common	2.20 ± 1.44	−0.78*	0.036
	Early-novel	3.09 ± 1.91	0.11	0.752
	Late-common	3.98 ± 2.14	1.00**	0.007
	Late-novel	4.11 ± 1.09	1.13**	0.003
Originality(Control:1.98 ± 0.41)	Early-common	1.88 ± 0.53	−0.10	0.409
	Early-novel	2.41 ± 0.64	0.42**	0.001
	Late-common	1.87 ± 0.40	−0.10	0.381
	Late-novel	2.29 ± 0.77	0.30	0.019
Flexibility (Control:1.71 ± 0.81)	Early-common	1.53 ± 0.82	−0.18	0.400
	Early-novel	1.82 ± 0.81	0.12	0.585
	Late-common	3.17 ± 1.36	1.46***	0.000
	Late-novel	3.34 ± 0.97	1.64***	0.000

Note: * indicates $p < 0.05$; ** indicates $p < 0.01$; *** indicates $p < 0.001$. *Example* indicates the example groups including Early-common, Early-novel, Late-common, Late-novel groups. *Control* indicates the control group with no example presented.

seemed not to interact with their timing effect on DT performance. Hypothesis 2 was not supported. This may result from the specific characteristics of RPP (i.e. a more realistic task). RPP is the problem situation from daily life, individuals may depend on their memory rather than combination concepts from memory (Runco et al., 2016). Therefore, the ideas generated may not present the same way as the order effect of creativity. Moreover, evaluation of examples may also affect the utilization of examples during the task (Jonge, Rietzschel, & Yperen, 2018). Thus, Study 2 using the classic AUT as the DT task was conducted to further test hypothesis 1 and 2.

3. Study 2

In order to examine the generalization of the findings in Study 1, and to determine the effect of example evaluation on example utilization, Study 2 was conducted.

3.1. Participants and design

A priori power analysis using G*power 3.1 (Faul et al., 2007) was also conducted to estimate the sample size. According to the results, the required sample size is 196. In order to prevent practice effect, participants from Study 1 were not considered for Study 2. We recruited 240 participants online. A 2 (Timing: early vs. late) × 2 (Quality: novel vs. common) between-subject design was employed. In addition, the experiment set a control group where no example was presented. Participants were randomly assigned to one of the five experimental groups.

Among the 240 participants, 33 were excluded because they failed to complete all items. Thus, the final sample consisted of 207 participants (178 females, 29 males; age: 20.71 ± 3.94). There were respectively 41, 44, 41, 41 and 40 participants in the early-common, early-novel, late-common, late-novel and control groups (As Pearson Chi-square test showed significant difference in gender ratios among the five experimental groups, $\chi^2 = 15.38$, $p = 0.004$, the complementary analysis using gender as a covariate were presented in the results section). All participants were right-handed and native speakers of Chinese. They gave written informed consent prior to the experiment and received approximately 5 US dollars for their participation. The experiment protocol was approved by the Institutional Ethics Committee of the University.

3.2. Procedure

The procedure of study 2 was similar to study 1. Participants were asked to complete one AUT in five minutes. Participants were asked to generate as many and original uses as possible for 'newspaper' in five minutes. Common or novel ideas were presented in the form of text for one minute at the beginning or late stage of the task. Differing from Study 1, Study 2 required participants to evaluate their need for inspiration immediately after the presence of examples. During the task, participants were asked to type their ideas into the computer.

3.3. Creativity task and assessment

AUT is a well-established test of creative potential (Guilford, 1967; Runco & Mraz, 1992). It requires participants to generate as many and original uses as possible for common objects. The prompt for AUT is newspaper. The examples used in this experiment were the same as those used in a prior research (Zhao, 2015), where examples were obtained from ideas generated by 10 people in the pre-experiment. Idea novelty was assessed by the CAT. Three raters rated 1 to 5 points on those ideas. The inter-rater reliability of this method was satisfactory ($\alpha = 0.96$). Novel examples were ideas scored above the medium while the common examples were those under the medium. Specifically, novel examples were "*a flower basket*" and "*a swing*" while the common ones were "*write*" and "*sell*".

Paralleling RPP performance, AUT performance was evaluated in terms of fluency, originality and flexibility (Guilford, 1967; Runco & Pritzker, 1999). Fluency was measured as the number of non-redundant ideas generated by the participant. For originality,

five raters scored each idea by using a 5-point Likert scale (1 = unoriginal, 5 = original). Inter-rater reliability on these scores was 0.98. For flexibility, three raters independently rated the total number of categories to which the reported responses belong for each participant. Inter-rater reliability on these scores was 0.65. The final originality and flexibility scores for each participant were obtained by averaging the individual ratings from the raters.

3.4. Post-example tests

Immediately after the presenting of examples, participants were asked to evaluate the examples using a 5-point Likert scale (four questions). One typical question is listed as follows: "*how do you need these examples as a hint*?".

3.5. Results

3.5.1. The effects of timing and quality on creative ideation

A two-way MANOVA with Timing (early vs. late) and Quality (common vs. novel) as the between-subject factors was performed on fluency, originality and flexibility. *Box's M* = 72.203, $p < 0.05$. The results showed that the covariance matrices of these dependent variables were not homogeneous, thereby the data did not fit MANOVA. Thus, a series of ANOVAs using Timing and Quality as between-subject factors were conducted on fluency, originality and flexibility.

For fluency, a significant main effect of Timing was observed, $F(1, 163) = 29.38$, $p < 0.001$, $\eta_p^2 = 0.15$. Participants in the late group had higher fluency ($M = 7.32$, $SD = 2.93$) than those in the early group ($M = 5.18$, $SD = 2.23$, $p < 0.001$, Cohens' d = 0.82). No significant main effect of Quality was found, $F(1, 163) = 0.163$, $p = 0.69$. In addition, a significant interaction effect of Timing × Quality was found, $F(1, 163) = 7.14$, $p = 0.008$, $\eta_p^2 = 0.04$. Specifically, for the late groups, participants in the late-novel group had higher fluency ($M = 7.95$, $SD = 3.16$) than those in the late-common group ($M = 6.73$, $SD = 2.59$, $p = 0.026$, Cohens' d = 0.42). However, for the early groups, no difference was observed between the early-novel ($M = 4.73$, $SD = 2.32$) and early-common groups ($M = 5.63$, $SD = 2.07$, $p = 0.105$) (see Fig. 2).

With respect to originality, significant main effect of Quality was observed, $F(1, 163) = 12.16$, $p = 0.001$, $\eta_p^2 = 0.07$. Participants in the novel example group had higher originality ($M = 2.34$, $SD = 0.43$) than those in the common example group ($M = 2.15$, $SD = 0.27$, $p = 0.001$, Cohens' d = 0.53). No significant main effect of Timing and interaction effect of Timing × Quality were found, $F(1, 163) = 1.42$, $p = 0.24$; $F(1, 163) = 1.46$, $p = 0.23$; (see Fig. 2).

With respect to flexibility, a significant main effect of Timing was found, $F(1, 163) = 96.62$, $p < 0.001$, $\eta_p^2 = 0.37$. Participants in the late group had higher flexibility ($M = 4.78$, $SD = 1.50$) than those in the early group ($M = 2.89$, $SD = 0.94$, $p < 0.001$, Cohens' d = 1.51). No significant main effect of Quality was found, $F(1, 163) = 0.29$, $p = 0.59$. Moreover, a significant interaction effect of Timing × Quality was found, $F(1, 163) = 4.78$, $p = 0.03$, ηp2 = 0.03. Specifically, for the late groups, participants in the late-novel group had higher flexibility ($M = 5.05$, $SD = 1.56$) than those in the late-common group ($M = 4.52$, $SD = 1.41$, $p = 0.047$, Cohens' d = 0.36). However, for the early groups, no difference was observed between the early-novel ($M = 2.73$, $SD = 0.98$) and early-common groups ($M = 3.05$, $SD = 0.89$, $p = 0.25$) (see Fig. 2).

3.5.2. Examples' effect on creative ideation

To examine the facilitating effect of examples on AUT performance, a one-way MANOVA with Example (example groups vs. control group) as the between-subject factor was conducted on fluency, originality and flexibility. *Box's M* = 138.98, $p < 0.05$. The results showed that the covariance matrices of these dependent variables were not homogeneous, thereby the data did not fit MANOVA. Thus, a series of ANOVAs using Example as the between-subject factor were conducted on fluency, originality and flexibility.

For fluency, participants in the example groups including early-common, late-common, and late-novel groups had higher fluency than those in the control group. These findings were parallel to Study 1. For originality, participants in the early-novel and late-novel groups had higher originality than those in the control group. For flexibility, participants in the early-common, late-common, and late-novel groups had higher flexibility than those in the control group (see Table. 2).

3.5.3. The effect of example evaluation on creative ideation

A two-way MANOVA with Timing and Quality of example as the between-subject factors was performed on examples evaluation.

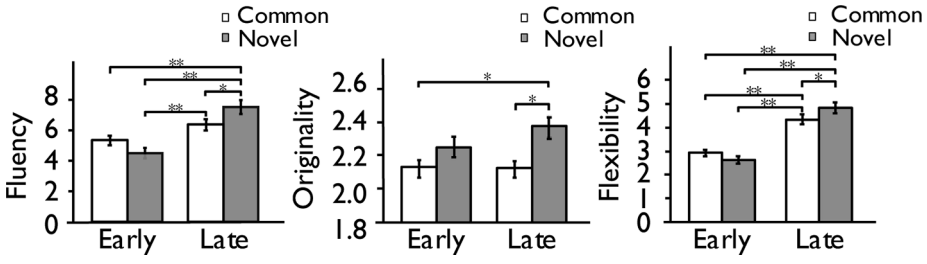

Fig. 2. Responses of Fluency, Originality and Flexibility in early-common, early-novel, late-common and late-novel groups (AUT). Error bars indicate standard errors of the mean. * $p < 0.05$; ** $p < 0.01$.

Table 2
AUT fluency, originality and flexibility among experimental groups in study 2.

Dependent variables	Group	Scores ($M \pm SD$)	(Example vs. Control)	p
Fluency (Control: 4.23 ± 2.25)	Early-common	5.63 ± 2.07	1.41*	0.012
	Early-novel	4.73 ± 2.32	0.51	0.365
	Late-common	6.73 ± 2.59	2.50***	0.000
	Late-novel	7.95 ± 3.16	3.73***	0.000
Originality (Control:2.02 ± 0.15)	Early-common	2.15 ± 0.30	0.13	0.080
	Early-novel	2.27 ± 0.43	0.25**	0.001
	Late-common	2.15 ± 0.25	0.13	0.077
	Late-novel	2.41 ± 0.43	0.39***	0.000
Flexibility(Control:2.38 ± 1.06)	Early-common	3.05 ± 0.89	0.67*	0.184
	Early-novel	2.73 ± 0.98	0.36	0.780
	Late-common	4.52 ± 1.41	2.15***	0.000
	Late-novel	5.05 ± 1.56	2.67**	0.000

Note: * indicates $p < 0.05$; ** indicates $p < 0.01$; *** indicates $p < 0.001$.
Example indicates the example groups including Early-common, Early-novel, Late-common, Late-novel groups. *Control* indicates the control group with no example presented.

The results showed a significant main effect of Quality on self-rated need for examples, F (1, 163) = 6.55, p = 0.011, η_p^2 = 0.04. Specifically, individuals rated original examples (M = 3.37, SD = 1.13) higher than common ones (M = 2.91, SD = 1.19) on the need for examples. No other main effect or interaction effect was observed.

3.5.4. *Differences of examples' effect between RPP and AUT*

To investigate the differences of examples' effect between RPP and AUT, a three-way MANOVA with Task type (RPP vs. AUT), Timing, and Quality as the between-subject factors was conducted on fluency, originality and flexibility. A significant interaction effect of Task type × Timing × Quality was found for fluency, F (1, 323) = 8.99, p = 0.003, η_p^2 = 0.03. A marginal significant interaction of these three factors was observed for flexibility, F (1, 323) = 3.76, p = 0.053, η_p^2 = 0.01. In particular, no interaction of Timing × Quality was found in RPP (for details see section 2.5.1 in study 1) whereas an interaction of Timing × Quality was found in AUT. Specifically, in the late conditions, the novel-example group showed higher fluency and flexibility than the common-example group whereas no group difference of fluency and flexibility was found in the early condition (for details see section 3.5.1 in study 2). However, interaction of Task type × Timing × Quality was not significant for originality, F (1, 323) = 1.27, p = 0.26.

3.6. *Interim discussion*

The effect of examples was directly compared for the two stages of creative idea generation: early stage and late stage. Performance of fluency and flexibility was better in the late stage than those in the early stage of task. The results replicated those in Study 1. This indicates the robustness of examples' timing effect on DT's fluency and flexibility but not on originality, which can be generalized from RPP to AUT.

The results also showed that when examples were presented in the late stage of task, novel ones were more effective than common ones for fluency and flexibility. This partially supported Hypothesis 2. Besides, example evaluation did not modulate the interaction of examples' timing × novelty. Note that hypothesis 2 was not supported by Study 1. It is possible that participants' process of RPP and AUT are different when seeking inspiration from examples. As RPP is more realistic than AUT, it is likely solutions generated during RPP mostly come from long-term memory rather than creation (Runco et al., 2016).

4. General discussion

This study aimed to address the question of "when" and "what" examples can stimulate verbal DT most. In both RPP and AUT, examples presented in the late stage of task led to better DT performance like fluency and flexibility than those in the early stage of task. Besides, novel examples in the late stage facilitated DT's fluency and flexibility more than those in the early stage during AUT.

Consistent with hypothesis 1, both studies indicated that examples presented in the late stage of task facilitated fluency and flexibility more than those in the early stage. These results indicate the example's timing effect can generalize from design studies to verbal DT. Previous studies have demonstrated that people benefit more from examples when they reach an impasse (Gray, McKilligan, Daly, Seifert, & Gonzalez, 2019; Madjar, Shalley, & Herndon, 2018; Siangliulue et al., 2015). For example, Gray and colleagues have found that after 30 min on design a sitting unit task, participants performance in the second 30 min benefited from design cues more than that of whom working on their own. Researchers concluded people can recognize and use examples when they run out of their ideas. In our studies, the late stage of task is the quasi-moment when people got stuck to think out of new ideas. This is consistent with the "open goal" account (Tseng et al., 2008). That is, when people have something unsolved are more likely to use environmental cues to solve problem. Moreover, drawing on the associative model of creativity (Mednick, 1962), with expansion of semantic network's activation in the late stage of task, individuals may become more sensitive to cues that fits with the current semantic status. However, inconsistent with previous studies, the current study showed DT performance of originality was not affected by example timing. This may because serial order effect exceeds the examples' effect on originality. Another explanation is that the cognition mechanism

underlying DT may be different from the design process. Further investigation is needed in the future study to compare examples' effect on domain-specific and domain-general creativity.

As to the effect of example quality, both studies found novel examples can boost DT more than common ones. In the least-resistant path theory, Finke (1992) proposed that people prefer to use knowledge that can be easily acquired. Compared with novel ideas, common or near ideas are easier to use and cause fixation as a result (Wang & Nickerson, 2019). In the current studies, common ideas may cause participants to fix their attention on these easily used examples. That is, ideas generated in common-example group are less original and flexible than those in novel-example group.

With regard to the role of novelty in examples' timing effect, Study 2 revealed that novel examples stimulated better DT's fluency and flexibility than common ones in the late stage of task. Hypothesis 2 was partially supported. According to the temporal pattern of DT, ideas generated later are the connection of more distant ideas than those generated earlier (Christensen et al., 1957; Xue et al., 2018). Thus, in the late stage, individuals' current active semantic network may be ready to recognize and use novel examples (Kenett, 2019). However, this phenomenon was not found during RPP in Study 1. As RPP focuses on situations that participants might actually experience, it is closely related to reality and natural environment. The role of semantic memory structure in AUT and RPP may be distinct from each other (Kenett, 2019). Therefore, the current semantic state in the late stage of AUT and RPP may be different, which results in the different impact of novel examples in the task's late stage. Moreover, the semantic temporal pattern of DT is often demonstrated by using AUT rather than RPP (Beaty & Silvia, 2012). Future research should examine the generalization of the findings by using other DT tasks.

Regarding the whole examples' effect, results of study 1 are a little different from those of study 2. Fluency was decreased in early-common group in comparison with control group in study 1 while fluency in study 2 was increased in early-common group in comparison with control group. This indicated the examples effect may vary across different DT tasks. The generalization of examples effect should be investigated further through various kinds of tasks in the future research. It may suggest that common examples may cause fixation under some conditions but cause inspiration in other conditions. The mechanism of example effect during creative idea generation should be explored further.

Previous research has demonstrated the effects of idea elaboration on fluency, originality and flexibility. For example, Dippo (2015) have found that elaboration may hinder the production of original ideas in a time-limited situation. In order to exclude the role of idea elaboration (i.e. responses length) in examples' effect on DT, response length was treated as a covariate in the complementary analysis. The results showed that response length did not impact examples' effect on DT. This means idea elaboration may not affect examples effect during creative ideation. However, this is merely an exploratory analysis. Further investigation should be conducted to verify the mechanism underlying examples effect on idea elaboration in the future research.

The findings about the timing effect, as well as the role of example's novelty in this timing effect, advance our understanding of the relationship between example presenting and creativity. While this timing effect has been found in design studies (Perttula & Sipilä, 2007; Perttula & Liikkanen, 2006; Tseng et al., 2008), this study goes further and examines this effect in verbal DT. Although both of them are problems that demand creativity, the latter involves more semantic analysis. Utilizing RPP and AUT, these findings revealed the timing effect of examples and quality's role in it, which help support and refine theories of examples' inspiration.

This study has several limitations. First, although the interaction of examples' timing and quality on DT was observed in AUT, the mechanism behind this effect remains unknown. According to SIAM theory, creative divergent thinking is closely connected to semantic memory (Wang & Nickerson, 2019). The examples may prime individual's memory retrieval. With the activation of semantic network, different kinds of examples may function differently. Future research can explore this by examining the semantic distance between examples and individuals currently activated semantic state. Second, the time that individuals reach an impasse may depend on individual creative potential. Our complementary analysis showed individuals differed in their impasse state before exposing the late examples. Those who generated fewer ideas before the late examples benefited more from examples than those generated more ideas. Future studies should further directly explore the effects of example presenting on creative ideation of individuals with high or low creative potential. In addition, although this study was conducted online, participants' attention or task engagement was not directly assessed. To some extent, excluding participants who failed to complete the whole experiment (quitted halfway), may indirectly indicate that the remaining participants were of relatively high task engagement. Nevertheless, future studies should directly assess participants' task engagement or attention.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Appendix A. Supplementary data

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