**Relationship between creativity and depression: the role of reappraisal and rumination**

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# Abstract

Previous research has found mixed evidence about whether increased creativity is associated with higher depression. We investigated the relationship between creativity and depression, and the role of two emotion regulation strategies: rumination and reappraisal. Previous research has found that rumination is a common factor that contributes to creativity and depression, which we attempted to replicate using a simplified model. No research has tested the relationship between reappraisal frequency and creativity. We hypothesized that controlling for reappraisal frequency could reduce the correlation between creativity and depression, or even reverse the relationship. To test the hypotheses, we measured creativity, self-reported rumination tendency and reappraisal frequency, and trait depression in an online survey of *N*=200 participants. We found [describe results and conclusions]

*Keywords*: creativity, depression, reappraisal, rumination

# Introduction

There has been a long-standing belief that creativity and depression are related. This belief may have been inspired by the historical examples of great minds who suffered from depression, such as painter Edvard Munch, author Ernest Hemingway, poet Silvia Plath, and musical composer Tchaikovsky (Jamison, 1993, as cited in Greenwood, 2020). This idea may also be perpetuated by movie tropes or stereotypes of “tortured artists”, which suggest that extraordinary creative gifts come at a cost. Is the association between creativity and depression just a myth, or is it supported by scientific evidence?

Although many studies have investigated this question, the relationship between creativity and depression is not fully understood. There are theoretical reasons to expect that creativity might be either positively or negatively related to depression, as discussed later. Some studies have found evidence that higher creativity is associated with higher depression (e.g. Ludwig, 1992; MacCabe et al., 2018; Papworth et al., 2008; Taylor et al., 2017), while other studies failed to replicate a positive association using similar methods (e.g. Chermahini & Hommel, 2012; da Costa et al., 2015; Kyaga et al., 2013; Silvia & Kimbrel, 2010). The inconsistent findings have inspired research on possible mediating factors (Verhaeghen et al., 2005). In this study, we investigate the relationship between creativity and depression and the role of emotion regulation strategies.

## Creativity

Creativity is defined as the tendency to generate novel and functional ideas that are useful in problem-solving, communications, and entertainment (Franken, 1994).

Creativity is a multidisciplinary concept and researchers have approached it in different ways. For instance, Kaufman and Beghetto (2009) have proposed the Four C model (mini-c, little-c, Pro-c, Big-C), which divides creativity into four developmental levels of gradual expertise. Others have categorised creativity into domains (e.g. everyday, visual, verbal, performance, scientific etc.) (e.g. Taylor, 2017; Villanova & Cunha, 2020), creative achievements (e.g. Carson et al., 2005), creative professions (e.g. Ludwig, 1992), or creative activities (e.g. painting, writing, musical composition etc.) (e.g. Hocevar, 1980; Verhaeghen et al., 2005). It is also regarded as a relatively permanent and consistent dispositional trait that is linked to other stable attributes such as personality or intelligence (e.g. Feist, 1998; Puryear et al., 2017; Zhang et al., 2020).

One testable and reliable feature of creativity is divergent thinking. Divergent thinking is the thought process used to generate diverse and numerous ideas in a free-flowing manner (Razumnikova, 2012), in contrast to convergent thinking, which is to arrive at one single answer. Divergent thinking leads to originality (Kim, 2017; Runco & Acar, 2012), which is a central feature of creativity. Hence, divergent thinking abilities are indicative of creative thinking and creative potential (Cramond, 2020; Kim, 2017). In this study, we focus on divergent thinking as the primary measure of creativity.

Creativity is usually regarded as a strength and an advantageous trait, but studies have found it to be correlated with emotional instability and mental disorders (e.g. Ludwig, 1992; MacCabe et al., 2018; Papworth et al., 2008; Taylor et al., 2017). Hence, this study seeks to investigate and explain how creativity and depression are related.

## Creativity and depression – Evidence for positive relationship

Studies on the relationship between creativity and depression have reported mixed findings. A meta-analysis by Taylor et al. (2017) examined direct links between creativity and depression and found evidence that creative individuals exhibited more instances of mood disorders, including unipolar depression. This finding was also replicated by studies that only considered divergent thinking as the measure of creativity (e.g. Flood, 2006; Le et al., 2015; Sánchez et al., 2010). A systematic review by Holm-Hadulla et al. (2021) also found support for the positive association between creativity and depression, but it depended on the severity of depression. The findings of Hadulla et al. (2021) suggest that mild-to-moderate levels of disorders can motivate creative work, which helps to overcome emotional crises, while more severe illnesses will only inhibit creativity. Other studies have not observed any systematic relationship between creativity and depression (e.g. Foster et al., 2011; Grigorenko & Sternberg, 2001; Silvia & Kimbrel, 2010; Zabelina et al., 2014). Thus, there remains uncertainty about the overall relationship between creativity and depression.

The use of different measures of divergent thinking could contribute to the mixed findings. Studies of creativity and depression have used a variety of creativity measures, including verbal tasks like the Similes Preference Inventory (Flood, 2006) and the Alternative Uses Tasks (Silvia & Kimbrel, 2010), and figural tasks such as Test for Creative Thinking-Drawing Production (Le et al., 2015) and Abbreviated Torrance Tests for Adults (Zabelina et al., 2014). If depression is related to certain aspects of creativity, the apparent relationship might depend on the measure. In this study, we use the Torrance Test of Creative Thinking because it is the most commonly used for creativity research.

In addition to mixed empirical evidence for a positive relationship between creativity and depression, there are theoretical reasons to expect a relationship in the opposite direction (e.g. Baas et al., 2008; Chermahini & Hommel, 2012). This is discussed in the next section.

## Creativity and depression – Negative relationship?

While the expectation based on stereotypes would be a positive association between creativity and depression, there are reasons to expect that creativity would be associated with lower depression. When the effect of depression on creativity is considered, the expectation would be lower creativity with greater depression. In the other direction, creativity is associated with some traits that are known to protect against depression, and creative activities can help to reduce depression. These observations seem to conflict with the empirical findings of a positive relationship between creativity and depression.

Becoming depressed would not generally lead to enhanced creativity, and instead would be expected to inhibit creativity. Depressed individuals often experience anhedonia, a loss of interest and decreased energy, which inhibits creativity (Shapiro & Weisberg, 1999; as cited in Verhaeghen et al., 2005). Studies have shown that creativity is enhanced by positive affect and approach motivation, while sadness and depressed moods are deactivating moods and are not associated with creativity (Baas et al., 2008).

Creative individuals have traits that would be expected to reduce depression. Some studies have found that creativity is associated with higher emotional intelligence, as indicated by low alexithymia and high empathy (da Costa et al., 2015; Xu et al., 2019). Emotional intelligence entails the ability to perceive, express, regulate and reason with emotions (Mayer & Salovey, 1997). Studies show that emotional intelligence is associated negatively with depression and positively with a better overall mental wellness (Kousha et al., 2018). This suggests that creative people, who are found to have higher emotional intelligence, can better understand and manage negative emotions, leading to a more positive emotional outcome. Creative people have also been found to have better reappraisal ability, which is an emotional regulation strategy associated with lower depression (Troy et al., 2010; Weber et al., 2014).

Another reason is that creative people would be expected to have less depression is that creative activities have been shown to have therapeutic effects (Leckey, 2010). These activities include painting, making handicrafts, writing a journal, playing a musical instrument, drama performance and so on. Studies showed that taking part in creative activities as a leisure or a hobby acts as a buffer against depression (Israel et al., 2020). It was also suggested that creative activities can unlock access to the flow experience, which is linked to an improved mental well-being (Chilton, 2013). These findings have established practical implications for art therapy theories and mental health interventions. Research has also indicated that the divergent thinking elements within a creative thinking task can induce systematic mood swings, leading to a more positive mood, as opposed to depressed emotions (Chermahini & Hommel, 2012).

 If creativity is associated with greater tendency toward depression despite these advantages, it would suggest that the relationship is due to some other factor that is related to depression. In the next section, we discuss self-reflective rumination as a potential mediator.

## Emotion regulation strategy: Rumination

Self-reflective rumination has been found to be a common trait for people who are creative and people suffering from depression (Verhaeghen et al., 2005). Rumination usually involves repetitive thoughts about the past and present, causes and consequences, which results in and maintains negative moods (Sansone & Sansone, 2012; Smith & Alloy, 2010). Rumination is a hallmark symptom of depression (Alderman et al., 2015) and is generally considered as a maladaptive emotion regulation strategy (ERS; Aldao et al., 2010). However, rumination could also be recognized as a style of thought that is repetitive and perseverative, detached from its negative contents and affect (Nolen-Hoeksema et al., 1993). Nolen-Hoeksema et al. (2008) proposed that this underlying style of thinking, with features of introspection, pondering, and an analytical assessment of problems, has commonalities with the adaptive strategy of self-reflection - the genuine curiosity about the self (Verhaeghen et al., 2005). Therefore, self-reflection can be considered as an adaptive type of rumination, which is defined as the recurrent thoughts that focus on the self, inner memories, and feelings (Verhaeghen et al., 2014).

Verhaeghen et al. (2005) found that self-reflective rumination is a confounding factor that explains the link between creativity and depression. They found no direct relations between creativity and depression, instead reporting that self-reflection independently increases the risk for depression and boosts creative interests and abilities simultaneously. The relation between self-reflective rumination and depression is due to self-directed attention or self-focus, which was found to induce negative moods (Mor & Winquist, 2002, as cited in Verhaeghen et al., 2005). Self-reflective rumination is also associated with creativity as people who reflect upon their lives frequently tend to be more motivated to seek creative outlets to share their emotions and use their negative moods as information to inspire new ideas (Watkins & Mason, 2002, as cited in Verhaeghen et al., 2005).

However, the influence of self-reflective rumination was established within a complex path model involving the relationships between the past and current depression, self-reflective rumination, divergent thinking, creative interests, and creative behavior (Verhaeghen et al., 2005). In an attempt to simplify the model, we only tested divergent thinking as a measure of creativity, self-reflective rumination, and trait depression. We hypothesized that the association between creativity and depression will decrease when self-reflective rumination is controlled. This could provide a clearer and more direct understanding of how self-reflective rumination is related to creativity and depression.

## Emotion regulation strategy: Reappraisal

Reappraisal is another emotion regulation strategy (ERS) found to be associated with creativity (e.g. Fancourt et al., 2019; Orkibi et al., 2021; Perchtold-Stefan et al., 2021; Wu et al., 2017). Reappraisal (or cognitive reappraisal) is the cognitive change that involves altering our perceptions and reinterpreting a situation to reduce the negative impacts (Gross, 2002). For example, if you received a bad grade on a course, the immediate reaction could be to fixate on the failure and feel frustrated. But, with reappraisal, one may look on the bright side, such as thinking that at least you did not fail, or find a silver lining, such as how this experience gave you a deeper understanding of your strengths and weaknesses. Reappraisal is regarded as an adaptive ERS. It is found that people who use reappraisals more often tend to have more positive emotions and an overall improvement in psychological health (Megías-Robles et al., 2019).

Researchers have distinguished the two facets of reappraisal: ability and frequency (Southward et al., 2021; Troy et al., 2010). Reappraisal ability is the ability to generate reinterpretations that are effective in changing mood. For example, in response to the negative thought of "I'm worthless", a low-quality reappraisal would be "I'm not worthless" (Southward et al., 2021). By contrast, a more effective reappraisal would be more elaborated and contextualized, such as "Every person, including me, is inherently worthwhile. I'm also a committed partner who works hard at my job and cares for people in my community" (Southward et al., 2021). As for reappraisal frequency, it represents the habitual use of reappraisal in daily life (Liu & Thompson, 2017; Weber et al., 2014). The ability and frequency of reappraisal are found to be independent and unrelated to each other (Troy et al., 2010; Weber et al., 2014). Hence, the two factors may affect depression differently.

## Reappraisal and depression

Reappraisal ability has been found to be negatively associated with depression. It was found that people with higher reappraisal ability exhibited fewer depressive symptoms (Troy et al., 2010). Southward et al. (2021) also found that among people with low levels of depression, reappraisal ability can cause significant affective change, while reappraisal frequency has little effect. In their experiment, participants who had lower depressive symptoms reported that they experienced a greater decrease in negative affect due to the quality of the reappraisals, regardless of how frequently they used reappraisal in their daily lives (Southward et al., 2021).

Similarly, reappraisal frequency is also found to be negatively associated with depression. Many studies have demonstrated a strong relation between reappraisal frequency and depression (e.g. Joormann & Gotlib, 2010; Megías-Robles et al., 2019). According to Southward et al. (2021), although reappraisal ability can cause significant mood change in people at low levels of depression, reappraisal frequency is more important than reappraisal ability for inducing mood change for people with high levels of depression. Studies also showed that depressed people have significantly lower reappraisal frequency than people at lower levels or without depression (Aldao et al., 2010; Southward et al., 2021). Still, Liu and Thompson (2017) found that when instructed to implement cognitive reappraisals to regulate happy and sad emotions, their reappraisals are as effective as non-depressed controls (Liu & Thompson, 2017). This shows that although depressed people may use reappraisal less frequently, they may not lack reappraisal ability. The underutilization of reappraisals could be due to low self-efficacy beliefs and the self-perception of low reappraisal ability, which is not representative of their actual ability (Dryman & Heimberg, 2018; Liu & Thompson, 2017).

## Creativity and reappraisal

Reappraisal ability is found to be strongly linked to creativity through divergent thinking. People who are highly creative are found to have higher divergent thinking abilities (Runco & Acar, 2012), which allows them to come up with novel reappraisals that effectively reassess a bad situation from multiple perspectives. This is because the process of generating novel reappraisals is similar to that of generating ideas during creative thinking. The measures for reappraisal ability (e.g. Reappraisal Generation tasks, Reappraisal Inventiveness Test, or the Script-based Reappraisal Test) were also developed based on divergent thinking theories and activities, and it was found that the scores of a creative thinking test can predict reappraisal ability (Wu et al., 2017). Neuroscientific studies have also found supporting evidence: when observed under an EEG or an fMRI, reappraisals involve the same cognitive processes and activates the same brain region as generating verbal creative ideas (Fink et al., 2017; Perchtold et al., 2018), which are the same verbal tasks used in the current study. Furthermore, research has found that the more creative the reappraisal is, the more effective it is in alleviating discomfort (Wu et al., 2017). These findings suggest a strong association between creativity and reappraisal ability.

Nonetheless, there appears to be a paradox regarding how reappraisal, creativity, and depression are related to one another. There is evidence that creative people tend to have higher reappraisal ability, and that higher reappraisal ability is associated with less depression. Based on these findings, higher creativity should be associated with lower depression (a negative association). However, this inference contradicts the studies that shows creativity being associated with greater depression (a positive association). No studies have reported lower depression among creative people compared to non-creative individuals, as might be expected based on their reported better reappraisal ability.

One possible explanation is that other factors counteract the potentially beneficial effect of higher reappraisal ability among creative individuals - namely, the effect of reappraisal frequency. Reappraisal frequency is believed to be independent of reappraisal ability (Weber et al., 2014), so it may be associated with creativity in a different way. No studies have investigated the relationship between creativity and reappraisal frequency. Based on this missing link, as well as the mixed evidence regarding the association between creativity and depression, we hypothesized that reappraisal frequency may have a suppressing effect on these variables, which could change the relationship between creativity and depression. It is possible that even though creative people are skilled in reappraisals, they might not access this ability habitually, which increases depressive tendencies. In this case, when we control for reappraisal frequency, a negative relation between creativity and depression could emerge. Alternatively, it is also possible that there is no systematic relationship between creativity and reappraisal frequency - perhaps creative people do not differ in the use of reappraisal frequency compared to non-creative people. In this case, the relationship between creativity and depression remains unchanged when reappraisal frequency is introduced.

## Gender and emotion regulation strategies

If the relationship between creativity and depression is mediated by ERSs, it could be different depending on gender. There is some evidence that the effects of ERSs on depression are moderated by gender. Several studies have found that women tend to ruminate more than men, which accounted for greater depression in women Preston et al. (2021) found a similar moderating effect for reappraisal frequency: women reported greater use of reappraisal compared to men, which was negatively related to depressive symptoms only for women. However, other studies investigating the effects of ERSs failed to find moderation by gender Given these inconsistent findings, it is unclear whether gender would be expected to moderate the relationship between creativity and depression.

## The present study

The current study investigates how ERSs could explain the connection between creativity and depression. Specifically, we examined how creativity is associated with the normal variations of depression in the general population through the use of rumination and reappraisal.

First, our study addressed the basic question of (1) whether there is an overall positive association between creativity and depression.

Second, we added self-reflective rumination to our present model of creativity and depression. Based on the findings by Verhaeghen et al. (2005), they showed that self-reflective rumination is a confounding variable while there no direct relation is detected between creativity and depression. We hypothesized that (2) when self-reflective rumination is controlled, the positive association between creativity and depression will be reduced.

Third, we hypothesized that reappraisal frequency could influence the relation between creativity and depression. We added reappraisal frequency to our model as a suppressor for the relationship of creativity and depression. We predicted that (3) when reappraisal frequency is controlled, the positive association between creativity and depression will be reduced further or even become negative.

In addition to testing these main hypotheses, we also tested whether gender moderates the relationship between ERFs and depression, and between creativity and depression.

# Methods

## Preregistration

The research plan was preregistered on OSF prior to data collection: [?? Link here]. There was no deviation from the preregistered plan. [Alternate: if there were some deviations, describe here].

## Participants

A total of ?? participants were recruited through Amazon’s Mechanical Turk (MTurk) service. [Describe basic demographic information]. However, we excluded the data from ???Specific reasons for exclusion include failure to complete all sections (??? participants) and failure to follow instructions on attention check items (??? participants). The data from the remaining ??? participants were used for analysis.

 Because our aim was to evaluate normal variations of depression in the general population, we did not select based on previous experience with depression. Subjects varied from reporting no previous experience with depression to reporting severe depressive symptoms. We excluded people who have experience with Torrance Tests of Creative Thinking or any other creativity thinking tests, because prior experience with these tasks could improve their performance and increase their overall scores. Subjects with diagnoses of bipolar disorders and schizophrenia were also excluded, because these diagnoses are associated with the component of mania or positive symptoms, such as delusions and hallucinations, which are found to be associated with enhanced creativity (e.g. MacCabe, 2018; Power et al., 2015; Silvia & Kimbrel, 2010) and also higher depressive symptoms (Bosanac & Castle, 2013; McCormick et al., 2015; Stamouli, 2010; Upthegrove et al., 2017).

The target sample size was N = 200. This was the largest sample size that was feasible given funding and time constraints, and would be enough to detect small-to-medium correlations. The sample size provides 80% power to detect small effects of r>.19 and 95% power to detect medium effects of r>.25. Smaller effects could not be reliably detected, but trends could be used as the basis for further study. The width of the 95% confidence intervals for correlation estimates would range from .28 for small correlations (r<.2) to .21 for a medium correlation (r=.5). This would provide some information even if effects are too small to detect.

We conducted a pilot experiment with a convenience sample of N=122 using the same measures and procedure. The pilot data and analyses are available at https://osf.io/fczpd/. The pilot experiment found a small-to-moderate overall correlation between creativity and depression (r = .212, CI [.035,.376]), a strong overall correlation between rumination and depression (r = .614, CI [.489,.713]), and trend toward a small-to-moderate correlation between creativity and rumination (r = .175, CI [-.003,.342]). These results are generally consistent with the findings of Verhaeghen et al. (2005), who reported a correlation of *r* = .24 between self-reflective rumination and depression, and a correlation of *r* = .09-.35 between rumination and creativity measures (including fluency, originality, elaboration) in a large path model. Based on the pilot results and previous findings, our sample size of N=200 would have good power to detect relationships between creativity, rumination and depression.

However, our sample size may not be enough to reliably detect the relationship between reappraisal frequency and the other measures. Our pilot experiment found only a weak correlation between reappraisal frequency and creativity (*r* = .108, CI [-.071,.280]), and between reappraisal frequency and depression (*r* = -.088, CI [-.261,.092]). No previous studies have directly investigated the relationship between creativity and reappraisal frequency, but there have been studies of the relationship between reappraisal frequency and depression. A meta-analysis by Aldao et al. (2010) found evidence for a small-to-moderate correlation between reappraisal frequency and depression. The correlations observed in individual studies ranged from *r* = -.14 to -.29 and the overall correlation estimated across studies was *r* = -.17. The findings of Aldao et al. (2010) suggest that the relationship between reappraisal frequency and depression may be stronger than observed in our pilot experiment, but the expected correlations would still be relatively small relative to our sample size of N=200.

## Materials

The task and measures used in this study are described below. The full questions and scales are available at https://osf.io/fczpd/.

### Creativity

To measure creativity, we used a subset of four tasks selected from the verbal subscale of the Torrance Tests of Creative Thinking (TTCT; Torrance, 1966). TTCT measures creativity by using a set of open-ended idea-generation tasks, which engages divergent thinking abilities. TTCT is the most widely used creative test and has been regarded as the gold standard of creativity measure (Cramond, 2020). There are two modalities, TTCT-figural that requires mostly drawing responses and TTCT-verbal that elicits written or oral responses. Although studies have found that TTCT-figural to be a more comprehensive, reliable, and valid measure of creativity than TTCT-verbal (Kim, 2017), no online platforms offer a reliable solution to collect drawing responses, hence only the TTCT-verbal was chosen.

For each task, participants were asked to generate as many ideas as possible in under 2 minutes. An example of a task is “try to think of many different possible uses for a brick” (see Appendix B for the full questionnaire). Participants could not proceed to the next task until the 2 minutes had elapsed. The standard TTCT uses a 3 min response period per trial. We used a shorter duration because we were collecting data through an online platform, and we were concerned that a longer duration would deter people from participating.

The responses were manually screened to make sure that participants were performing the task as instructed. If responses were irrelevant to the instructions on any trials, the data from that subject was excluded.

Responses were rated on fluency (the number of ideas), flexibility (the number of categories), and originality (the number of novel ideas). Fluency is scored by counting the number of answers. Flexibility is scored by counting the number of categories. Originality is scored by counting how many times an answer is duplicated among other participants, which suggests that the answer is not original. To obtain the originality raw score, this number is inverted using 1/n. The sum of the three sub scores forms the creativity total score. There is little subjectivity in scoring and TTCT is largely reliable (Runco & Acar, 2012).

One rater scored the TTCT according to the guidelines on the TTCT interpretive manual (Torrance, 2018). Interrater reliability was assessed by having a second rater independently scored a subset of 30 responses. The intraclass correlation coefficient (ICC) across the items was ???, indicating [moderate/good/excellent] reliability in scoring.

 To prepare the TTCT data for analysis, the ratings on fluency, flexibility, and originality were added up to form a total creativity score, which was converted to a standard score with a mean of 100. According to the Interpretive Manual (Torrance, 2018), the frequency distribution usually captures a range of total scores from <50 to 150+. The total scores were used in the main analyses for our hypotheses, while the sub-scores of fluency, flexibility, and originality were used in the exploratory analysis.

### Rumination

Rumination tendency was measured using the 22-item Rumination Responsiveness Scale will be used (RRS; Nolen-Hoeksema & Morrow, 1991). ​​The RRS is a self-report measure that assesses the habitual tendency of rumination (see Appendix D for the full questionnaire). It is a commonly used measure in rumination research (Cohen & Ferrari, 2010). It includes 5 items measuring brooding, 5 items measuring self-reflection, while the rest are depression-related. Subjects rated how often they experienced different rumination tendencies on a 4-point scale (1 = almost never, 4 = almost always). An example of an item is "How often do you think about how alone you feel?". As only self-reflective rumination was found to be related to creativity (Verhaeghen et al., 2014), only the five items about self-reflection were analyzed, and the total scores were calculated by the average of sums of each Likert point, which range from 1 to 4.

### Reappraisal Frequency

Reappraisal frequency was assessed using the 10-item Emotion Regulation Questionnaire (ERQ; Gross & John, 2003). ERQ is a self-report that questionnaire assesses the emotional experience – how they feel on the inside, as well as behavioural expression – how they show their emotions through their behaviours and communication (Gross, 2002). Six items measure cognitive reappraisal while four items measure expressive suppression. Participants were asked to rate the statements on a 7-point scale (1 = strongly disagree, 7 = strongly agree; see Appendix C for the full questionnaire). An example of a Likert statement is “When I want to feel more positive emotion (such as joy or amusement), I change what I’m thinking about.” Only the six items on the reappraisal subscale were analyzed, and the total scores were calculated by the average of sums of each Likert point, which range from 1 to 7.

### Depression

We chose to measure trait depression instead of state depression, in contrast to some other studies (e.g. Baas et al., 2008; Perchtold et al., 2019; Verhaeghen et al., 2005). The rationale is that creativity is theorized to be a stable dispositional trait rather than a temporary state (e.g. Feist, 1998; Puryear et al., 2017; Zhang et al., 2020). If creative individuals have greater tendency toward depression, it would be revealed in trait depression as both variables are relatively permanent and consistent. Measuring trait depression also allows us to assess the normal variations of depression in the general population.

Trait susceptibility to depression was measured using the 18-item Maryland Trait and State Depression – Trait Scale (MTSD-T; Chiapelli et al., 2014). It is a self-report that measures the severity of depressive symptoms in their adult lives according to the diagnostic symptoms of DSM-V (see Appendix E for the full questionnaire). Participants were asked to indicate how often they generally feel in most of their adult life (in your whole life since age 12), excluding the past one week, on a 5-point scale (0 = never, 4 = experienced many times in a month for almost every month of my adult life). An example of a Likert statement is “It has been hard for me to feel happy throughout my life.” Each point on the Likert scale will add up to form a total score that ranges from 0 to 72.

### Data Quality Check

Since responses are collected through an online survey rather than a controlled environment, attention check questions were added to each questionnaire section to ensure participants’ paid attention to the study instructions. An example of an attention check “This is an attention check. Please select “strongly disagree” for this question.” There was one attention check question per questionnaire (RRS, ERQ, and MTSD-T respectively). Subjects who failed to answer them according to instructions were excluded in the analysis.

## Procedure

Participants completed an online questionnaire via MTurk and Qualtrics which took about 15 minutes. They first completed a timed creative thinking test with four questions and 2 minutes per question. Then, they answered questions about how they usually react to emotional situations and their emotional states. Participants were guaranteed anonymity (see Appendix A for the informed consent form). After completion of the questionnaires, each participant received ?? as financial compensation. The present study was approved by the Departmental Research Ethics Committee, Department of Psychology at The University of Hong Kong.

## Analysis Plan

### Creativity & Depression

To test the overall relationship between creativity and depression (see Hypothesis 1), we planned to perform a linear regression using creativity as the independent variable and depression as the dependent variable.

### Rumination

To test whether differences in self-reflective rumination contribute to the overall relationship between creativity and depression (see Hypothesis 2), we planned to perform a multiple regression analysis using both creativity and rumination as independent variables and depression as the dependent variable. If an overall correlation between creativity and depression was found in the initial analysis, we planned to conduct an additional mediation analysis to test whether there was a significant indirect effect of creativity on depression that is mediated by rumination. We planned to use the bootstrapping method (10000 samples) for the mediation analysis.

### Reappraisal frequency

To test whether reappraisal frequency acts as a suppressing variable for the relationship between creativity and depression (see Hypothesis 3), we planned to perform a multiple regression analysis using depression as the dependent variable and three predictors: creativity, rumination, and reappraisal frequency. If the mediation analysis for rumination and creativity finds a significant indirect effect on depression, we planned to repeat the analysis using reappraisal frequency as an additional control variable.

### Exploratory analysis – Creativity dimensions

If creativity was found to be associated with depression, reappraisal, or rumination, we planned additional analyses computing the correlation of these measures with three separate measures of creativity: fluency, flexibility, originality.

### Exploratory analysis – Moderation by gender

We planned to perform three additional regression analyses to test whether gender moderates the relationship between: rumination and depression, reappraisal frequency and depression, and creativity and depression.

### Inference criteria

We used the standard *p*<.05 criteria to determine statistical significance.

# Results

## Descriptive Statistics

Descriptive statistics were shown in Table 2. ??? (???%) were females, ??? (???%) were males, and ??? (?? %) identified as other or preferred not to say. All subjects were at least 18 years old. The sample was divided into five age groups: 18-24 years old (??%), 25-34 years old (??%), 35-44 years old (??%), 45-54 years old (??%), and over 55 years old (??%).

Total creativity scores ranged from ?? to ?? (*M* = ???, *SD* = ???), while the scores of depression ranged from ?? to ?? (*M* = ???, *SD* = ???). The scores of self-reflective rumination ranged from ?? to ?? (*M* = ???, *SD* = ???) and the scores of reappraisal frequency ranged from ?? to ?? (*M* = ???, *SD* = ???).

## Creativity and Depression

To test the overall relationship between creativity and depression (see Hypothesis 1), we performed a simple linear regression using the creativity score as the independent variable (IV) and tendency toward depression as the dependent variable (DV). We found that there was a significant positive relationship between creativity and depression (F(??,??) = ??, p = ??). The standardized beta (or correlation coefficient) was β = ??, indicating a ???-sized overall correlation between the creativity and depression measures.

[Alternate if no overall correlation is observed: To test the overall relationship between creativity and depression ... We did not find evidence for any overall relationship between creativity and depression (F(??,??) = ??, p = ??). The standardized beta (or correlation coefficient) was β = ???, with confidence interval [???,???]. Based on our results, any overall positive relationship between creativity and depression was at most a small correlation.

## Self-reflective Rumination

To test whether differences in self-reflective rumination contribute to the overall relationship between creativity and depression (see Hypothesis 2), we performed a multiple regression analysis using self-reflective rumination as an additional predictor of depression. Results are shown in Table 3.

We found that rumination was a significant and positive predictor of depression (β = ???, p <.001), and that creativity was no longer a significant predictor of creativity when rumination was included in the model (β = ???, p = ???). The confidence interval for the effect of creativity was [???,???]. If creativity does positively predict depression when rumination is controlled, our data suggests that the relationship is weak (r<???).

[If an overall correlation between creativity and depression was observed:]

We performed an additional mediation analysis to test whether differences in rumination could account for the observed overall relationship between creativity and depression. We used the bootstrapping method with 10000 samples. We found that there was a correlation between creativity and rumination (β = ???, p = ???), and also evidence for a significant indirect effect of creativity on depression mediated by rumination (β = ???, p = ???). This indicates that at least some of the overall relationship could be explained by differences in rumination.

[Alternative: We performed an additional mediation analysis … We found that there was a significant correlation between creativity and rumination (β = ???, p = ???), but there was not a significant indirect effect of creativity on depression mediated by rumination (β = ???, p = ???). Although rumination was confounded with creativity, it is unclear whether differences in rumination contributed to the overall correlation between creativity and depression.]

[Alternative: We performed an additional mediation analysis … We found no significant correlation between creativity and rumination (β = ???, p = ???), and no significant indirect effect of creativity on depression mediated by rumination (β = ???, p = ???). These results suggest that the overall relationship between creativity and depression is not due to differences in self-reflective rumination.]

## Reappraisal Frequency

 To test whether reappraisal frequency acts as a suppressing variable for the relationship between creativity and depression (see Hypothesis 3), we performed a multiple regression analysis using reappraisal frequency as an additional predictor of depression, along with creativity and self-reflective rumination. Regression results are shown in Table 4.

With reappraisal frequency added to the model, the results were largely unchanged. We again found that self-reflective rumination was a significant predictor of depression (β = ???, p = ???) and creativity was not a significant predictor (β = ???, p = ???). Reappraisal frequency was not a significant predictor of depression (β = ???, p = ???). Our results provide no evidence that reappraisal frequency has a direct relationship to depression, and controlling for reappraisal frequency did not change the qualitative relationships between other variables.

 [If the previous analysis found a significant indirect effect in the mediation analysis, repeat the mediation analysis with rumination as an additional predictor (not a mediator), and report the results here. Conclusion is either that rumination could account for the relationship between creativity and depression when reappraisal frequency is controlled, or that findings are ambiguous if reappraisal frequency is controlled.]

## Exploratory analysis: Creativity dimensions

We conducted an exploratory analysis using separate measures of creativity: fluency, flexibility, originality, and examined whether specific aspects of creativity are more related to the emotional regulation strategies or to depression.

Table 5 shows the correlation matrix computed using the raw scores of fluency (M = ???, SD = ???), flexibility (M = ???, SD = ???), originality (M = ???, SD = ???), reappraisal frequency, self-reflective rumination, and depression. As expected, there was a significant positive correlation among the three factors of creativity. Fluency and flexibility were found to be strongly positively correlated, r(???) = ???, p < .001, as were fluency and originality, r(120) = 0.869, p < .001, and flexibility and originality, r(???) = ???, p < .001.

All three aspects of creativity are significantly and positively correlated with depression: fluency, r((???) = ???, p = ???, flexibility, r((???) = ???, p = ???, and originality, r((???) = ???, p = ???. We also detected a small but significant correlation between originality and self-reflective rumination, r(???) = ???, p = ???. [Identify any other correlations]

## Exploratory analysis: Gender

We performed additional exploratory analyses to test whether gender moderates the relationships between rumination and depression, reappraisal frequency and depression, or creativity and depression. For each of the three IVs (rumination, reappraisal and creativity), we performed a multiple regression analysis with depression as the DV, and gender as a moderator of the IV.

For rumination and depression, we found evidence that gender was a moderator. There was a significant interaction effect between gender and self-reflective rumination on depression (β = ???, p = ???). Depressive symptoms increased with self-rumination for both males (β = ???, p = ???) and females (β = ???, p = ???). The interaction was due to a stronger positive relationship for males compared to females. Figure 2a plots the relationship between rumination and depression for males and females, illustrating the interaction effect.

For reappraisal and depression, there was no evidence for any effects or moderation. The interaction between gender and reappraisal was not significant (β = ???, p < ???). When data from males and females were analyzed separately, neither showed a significant relationship between reappraisal frequency and depression: males (β = ???, p = ???), females (β = ???, p = ???).

For creativity and depression, [describe the results. Possible finding: stronger relationship for males. If so, note that it is consistent with the rumination findings.]

# Discussion

## Overall relationship between creativity and depression

[Summarize the finding]

[If positive association, compare to previous studies that found no relation.]

[If no overall association, discuss possible reasons why: mediating or moderating factors, different measures.]

[Discuss trait depression (our study) vs state depression in other previous studies.]

## Rumination

[Summarize the finding of whether self-reflective rumination is a confounding factor for creativity and depression, and how the relationship between creativity and depression changes when self-reflective rumination is added to the model.]

[If association is found, discuss possible implications.]

[If no association, discuss how rumination is related to creativity and depression separately. Compare with Verhaeghen et al. (2005), discuss possible reasons why: different measures, samples]

## Reappraisal frequency

[Summarize the finding of whether reappraisal frequency is a suppressing variable between creativity and depression, and how the relationship between creativity and depression changes when reappraisal frequency is added to the model.]

[If a suppressing effect is found, discuss how reappraisal ability and frequency are related to creativity. Discuss possible implications.]

[If no effect is found, discuss how reappraisal frequency is related to creativity and depression separately.]

## Exploratory analysis: Creativity measures

[Our study measured divergent thinking, not other creativity measures – possible implications]

[If exploratory analyses found anything interesting, discuss here]

[Limitation of our study: shorter than standard Torrance test, online version might add variability.]

## Exploratory analysis: Gender

[If gender is found to be a moderator between rumination and depression; or between reappraisal frequency and depression, we will compare the results with previous studies and discuss implications. We will discuss how this informs the variance in our main hypotheses.]

## Conclusion

[Briefly summarize conclusions for the three main questions, and any other notable findings.]

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| --- | --- | --- |
| ***Table 1 - Research plan*** |  |  |
| **Question** | Is increased creativity associated with higher depression? | Does the relationship between creativity and depression change when self-reflective rumination is controlled?  | Does the relationship between creativity and depression change when reappraisal frequency is controlled? |
| **Hypothesis** | (1) Creativity is positively associated with depression. | (2) When self-reflective rumination is controlled, the positive association between creativity and depression will be reduced.  | (3) When reappraisal frequency is controlled, the positive association between creativity and depression will be reduced or even become negative.  |
| **Sampling plan** | We chose a sample size of N = 200 based on funding and time constraints. This sample size would have 80% power to detect small to medium effects of r>.19, and 95% power to detect medium effects of r>.25. The sample size would be able detect small to medium effect sizes, or report trends that could be used as the basis for further study. The width of the 95% confidence intervals for correlation estimates would range from.28 for small correlations (r<.2) to .21 for medium correlations (r=.5). This would provide some information even if effects are too small to detect. |
| **Analysis Plan** | We will perform a linear regression analysis, with creativity as the independent variable (IV) and depression scores as the dependent variable (DV).  | We will perform a linear regression analysis, with creativity (IV), self-reflective rumination (IV) and depression (DV). If an overall correlation between creativity and depression was found in the initial analysis, we will conduct an additional mediation analysis to test whether there was a significant indirect effect of creativity on depression that is mediated by rumination. We will use the bootstrapping method (10000 samples) for the mediation analysis. | We will perform a linear regression analysis, with creativity (IV), self-reflective rumination (IV), reappraisal frequency (IV) and depression (DV).If the mediation analysis for rumination and creativity finds a significant indirect effect on depression, we will repeat the analysis using reappraisal frequency as an additional control variable. |

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| **Hypothesis** | (1) Creativity is positively associated with depression. | (2) When self-reflective rumination is controlled, the positive association between creativity and depression will be reduced.  | (3) When reappraisal frequency is controlled, the positive association between creativity and depression will be reduced or even become negative.  |
| **Rationale for sensitivity** | Our pilot study (N=122) using the same measures found an overall correlation between creativity and depression of of r = .212. Our target sample size of N=200 provides 85% power to detect an effect with r = .212.  | Our pilot study found correlations of r = .641 between rumination and depression and r = .175 between creativity and rumination. Verhaeghen et al (2005) reported a correlation of r=.24 between rumination and depression, and correlations between rumination and creativity measures ranging from r = .09-.35. Our target sample size of N=200 provides 95% power to detect an effect of r>.25, and over 80% power to detect an effects of r >.19. | Based on previous studies, a small-to-moderate relationship between reappraisal frequency and depression would be expected (Aldao et al., 2010). However, our pilot study found only weak correlations between reappraisal frequency and creativity (r = .108) or depression (r = -.088). Our target sample size would not be enough to reliably detect these small associations, but the results would constrain the size of possible effect to a CI with width .28.  |

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| **Hypothesis** | (1) Creativity is positively associated with depression. | (2) When self-reflective rumination is controlled, the positive association between creativity and depression will be reduced.  | (3) When reappraisal frequency is controlled, the positive association between creativity and depression will be reduced or even become negative.  |
| **Interpretation given different outcomes** | We will follow the standard NHST to interpret the significance of our results.Creativity may or may not have an overall association with depression. If p>.05, we will compute the Bayesian inferential tests using creativity (IV) and depression (DV). We will report the Bayes factor and the 95% CIs of the estimated posteriors for the effects. This will provide some information about the strength of evidence if we observe non-significant trends. | We will follow the standard NHST criteria to observe whether the overall relationship between creativity and depression is positively associated when self-reflective rumination is introduced.We will also observe if the association between creativity and depression is reduced when self-reflective rumination is controlled, compared to the analysis with just creativity and depression in our first hypothesis.We will also present the path model and report the indirect, direct, and total effects of a mediation analysis.If p>.05, we will follow the same approach and compute the Bayes factor and 95% CIs using creativity (IV), self-reflective rumination (IV) and depression (DV).  | We will follow the same approach as rumination: use the standard NHST and observe how the relationship of creativity and depression has changed when reappraisal frequency is introduced to our model. We will observe whether the association creativity and depression is reduced when both reappraisal frequency and rumination are controlled. We hypothesize that the association may even become negative when reappraisal frequency is added.We will also follow the same approach as rumination if the mediation analysis is performed: present the path model and report the indirect, direct, and total effects of the analysis.If p>.05, we will use the same approach and compute the Bayes factor and 95% CIs using creativity (IV), self-reflective rumination (IV), reappraisal frequency (IV) and depression (DV).  |

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| **Hypothesis** | (1) Creativity is positively associated with depression. | (2) When self-reflective rumination is controlled, the positive association between creativity and depression will be reduced. | (3) When reappraisal frequency is controlled, the positive association between creativity and depression will be reduced or become negative. |
| **Theory that could be shown wrong by the outcomes** | Previous findings have been mixed. The results from this study could support previous findings that creativity is linked to depression or could support previous findings that there is no overall association. | Verhaeghen et al. (2005; 2014) measured state depression instead of trait depression, and used different measures of creativity. If the expected relations are not observed, it could be due to these differences in measures. | No previous studies have investigated the relation between creativity and reappraisal frequency. It is possible that reappraisal frequency is unrelated to creativity, such that when reappraisal frequency is controlled, the overall association between creativity and depression remains unchanged. This would inform us that the reappraisal frequency is not masking a negative relationship between creativity and depression. |