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Poetic Break: Incubation for Associative Creativity

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ABSTRACT

Creative thinking often improves during incubation, a phase where attention shifts away from the problem, generally involving mind-wandering. This study examined whether reading poetry could be an effective incubator for creative ideation. A total of 153 participants were randomly assigned to one of the three incubation conditions: reading a poem (reading), reading and rating the poem (rating), and reading non-poetic text (control). Creativity was assessed using Forward Flow (FF) for associative thinking and the Alternate Uses Task (AUT) for divergent thinking, both pre- and post-incubation. Participants reported their levels of mind-wandering during incubation and also completed a questionnaire assessing their daydreaming trait. Results showed that high mind-wandering in the reading condition significantly boosted associative thinking, while low mind-wandering decreased it. In contrast, associative thinking increased in the other conditions regardless of mind-wandering levels. No significant effects were observed on divergent thinking in any condition, and daydreaming traits did not influence the results. These findings suggest that poetry reading during incubation may effectively enhance free-flowing associative thought but does not necessarily stimulate the generation of entirely novel ideas.

PLAIN LANGUAGE SUMMARY

Taking a break and letting your mind wander – known as incubation – can boost creativity. This study explored whether reading poetry during a break could enhance creative thinking. A total of 153 participants were assigned to one of three tasks: reading a poem, reading and rating a poem, or reading a non-poetic text. Creativity was measured before and after, and participants reported their levels of mind-wandering during the tasks in the break. Poetry readers who experienced high levels of mind-wandering showed the greatest improvement in associative thinking (free-flowing ideas). However, no task improved divergent thinking (coming up with entirely new ideas). This study suggests that poetry reading can encourage associative creativity but may not spark entirely new ideas.

ARTICLE HISTORY

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Introduction

Creativity, usually defined as the capacity to produce work that is both original and useful (Runco & Jaeger, 2012), is a driver of human progress. Given its significance, researchers have long sought to understand the cognitive mechanisms that facilitate creative thought (Beaty et al., 2014; Haase et al., 2023; Heilman et al., 2003; Lloyd-Cox et al., 2023; Runco & Chand, 1995; Sweller, 2009). One intriguing area of exploration is the potential role of incubation – a period when individuals take a break from active problem-solving, allowing the unconscious mind to work on the problem leading to enhancing creativity.

The concept of incubation, first theorized by Wallas (1926), is the second stage of creative problem solving, following preparation and preceding illumination and verification. During incubation, conscious attention is

shifted away from the problem at hand, often leading to fresh insights upon re-engagement with the task. Incubation studies typically use either interpolated tasks, where participants work on a problem, take an incubation break, and then return to it, or multiple-trial designs incorporating optional incubation periods between problem-solving trials (Ritter & Dijksterhuis, 2014; Dodds et al., 2003).

Research on incubation has produced mixed findings regarding the cognitive demands of interpolated tasks. While some studies suggest that high-demanding tasks (e.g., mental rotation, counting backwards, visual memory tests) during incubation may boost creativity (Patrick, 1986; Segal, 2004), others favor low-demanding tasks (e.g., reading, relaxation) (Baird et al., 2012; Browne & Cruse, 1988). In their meta-analysis, Sio and Ormerod (2009) found that the

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benefits of incubation are more pronounced when individuals engage in undemanding tasks, compared to demanding tasks or no tasks at all. In an influential study, Baird et al. (2012) demonstrated that engaging in low-demanding tasks, such as the 0-back choice reaction time task, which involves responding only to a pre-specified target in a sequence, led to better incubation effects compared to more cognitively demanding tasks, such as the 1-back working memory task, which imposes greater cognitive demands, or a rest condition.

One cognitive mechanism by which incubation could facilitate creativity is postulated to be mind-wandering. Mind-wandering, often described as task-unrelated thoughts (Smallwood & Schooler, 2006), refers to “a shift in the contents of thought away from an ongoing task and/or from events in the external environment to self-generated thoughts and feelings” (Smallwood & Schooler, 2015, p. 488). It is characterized by spontaneous, unguided thinking and has been linked to enhanced creative problem-solving (Baird et al., 2012; Christoff et al., 2011; Tan et al., 2015; Yamaoka & Yukawa, 2016). When people engage in mind-wandering, their attention drifts away from the current task, making it easier to temporarily leave the problem and gain a new perspective, potentially reducing cognitive fixation (Smith & Blankenship, 1989). Neuroimaging research has shown that the brain’s default mode network (DMN) becomes active during mind-wandering, involving thoughts about the future, oneself, or others (Andrews-Hanna et al., 2014; Christoff et al., 2009; Mason et al., 2007). Importantly, regions within the DMN, which includes the medial prefrontal cortex (mPFC), the posterior cingulate cortex (PCC), the precuneus, and the bilateral inferior parietal lobes (IPL: Gusnard & Raichle, 2001) have been consistently associated with creative thinking (Benedek et al., 2014; Fink et al., 2009; Jung et al., 2010; Kühn et al., 2014). Although some studies suggest that mind-wandering during active engagement in creative tasks can disrupt performance (Hao et al., 2015), a growing body of evidence reports a positive relationship between mind-wandering and improved outcomes on widely used creativity measures, such as divergent and convergent thinking tasks (Leszczynski et al., 2017; see; Steindorf et al., 2021). This evidence indicates that creativity might benefit from mind-wandering. Daydreaming, a related construct, closely associated to mind-wandering (Christoff, 2012; Schupak & Rosenthal, 2009; Smallwood & Schooler, 2006, 2015), refers to an internally generated, spontaneous shift in conscious thought unrelated to the task at hand (Giambra, 1980). Individual differences in daydreaming frequency have been associated with creative thinking and problem-solving (Zedelius & Schooler, 2020; Zedelius

et al., 2021), highlighting the potential importance of both state and trait-level mind-wandering in understanding creativity.

Present study

This study investigates whether poetry, known for its rich linguistic expressions and emotional depth, can serve as an effective incubation to enhance creative cognition. Specifically, we investigate how poetry reading during a break from creative tasks might influence the incubation process for creative performance. In particular, we explore whether engaging with poetic texts stimulates mind-wandering, thereby acting as a catalyst for generating new solutions to old problems.

Poetry, with its capacity to evoke deep emotions (Wassiliwizky et al., 2017) and engage readers in reflective thinking (Moran, 2024), offers a unique context for studying creativity (Chaudhuri, 2024a, 2024b, 2024c). Poetic language encourages readers to suspend conventional interpretations and explore alternative meanings through various qualities, including its originality, imagery, aesthetic appeal, and surprise (Chaudhuri et al., 2024a; 2024b). However, little is known about its explicit impact on idea generation.

Previous studies have investigated art-related incubation tasks, such as art viewing (Ishiguro & Okada, 2021), visual aesthetic sensitivity (Myszkowski et al., 2014), painting (Kazemian et al., 2024; Okada & Ishibashi, 2017), and copying of geometric shapes (Browne & Cruse, 1988). Further, levels of felt creative inspiration during story-writing task have been shown to benefit from exposure to aesthetic, such as watching and rating aesthetic stimuli (Welke et al., 2023). However, the potential of literary texts, specifically poetry, as effective incubation task material has not been adequately explored. This study investigated whether poetry, with its specific modality of reading, could function as an effective incubation.

Methodology adopted and hypotheses

Based on the concept of incubation as a stage during which a problem is set aside and not consciously worked on (Wallas, 1926; see also Gilhooly et al., 2013), and recognizing that creativity can improve after a break or a period of distraction involving a task with low cognitive load, this study utilized a standard incubation paradigm (Baird et al., 2012). Here, we conceptualized the incubation condition as a period of distraction or interruption from an ongoing task, which can facilitate creative ideation. Participants in the incubation condition

initially worked on a target problem (here, associative thinking and divergent thinking tasks) for a set period (preparation period). This was followed by an interpolated activity (incubation period) of a fixed duration during which the participants were engaged with another task (here, reading task). After the incubation period (post-incubation period), participants revisited the target problem. The three incubation conditions involved different activities: poetry reading, poetry reading followed by poetry evaluation, and reading non-poetic texts. Immediately after the interpolated task, participants completed a well-established self-report measure of state mind-wandering (Matthews et al., 2013). This framework allowed us to investigate whether different reading tasks, associated with potentially varying levels of mind-wandering, could enhance creativity.

Following the established research design (Baird et al., 2012; Cai et al., 2009), this study evaluated participants' creativity performance on problems presented both before and after an incubation period (repeated exposure) and on entirely new problems introduced only after the incubation period (new exposure). Additionally, the effect of the break period on participants' creativity performance was examined as a control analysis. This design allowed us to examine three types of creative problem-solving improvements: (i) incubation effects, associated with the repeated-exposure and reflecting enhanced engagement with previously encountered problems; (ii) non-incubation effects, observed as general increases in creative problem-solving in the new-exposure (Baird et al., 2012); and (iii) simple break effects, where general improvements were assessed without considering incubation. For the incubation and non-incubation effects, we explored how participants' mind-wandering during the reading tasks influenced improvement, whereas, for the simple break effect, mind-wandering was not considered, focusing on potential influences of other psychological states (e.g., mood, arousal).

Unlike previous studies (Baird et al., 2012), this study did not assess participants' performance or cognitive engagement in the interpolated tasks during the incubation period to classify them as cognitively demanding or undemanding. Instead, the primary aim of this study was to evaluate how these tasks influenced creativity and mind-wandering, as reported retrospectively by participants. However, since the poetry rating group evaluated the poem after contemplating it, we presumably considered this task to be more cognitively engaging than the poetry reading-only task. In line with prior research suggesting that higher attentional demand reduces mind-wandering

(Baird et al., 2012; Smallwood et al., 2009), we expected participants in the poetry reading-only group to report higher levels of mind-wandering, potentially leading to greater creativity gains following the incubation period compared to other conditions, particularly the rating group. Specifically, based on findings by Baird et al. (2012), we anticipated that performance improvements would primarily occur in repeated-exposure problems rather than in new-exposure problems, confirming that the observed gains were attributable to incubation rather than general enhancements in creative problem-solving. We also expected that the poetry rating condition might yield some creativity gains, although these gains are expected to be smaller due to the higher attentional demand associated with evaluating poems.

Materials and methods

Stimulus selection

This study explored how poetry, particularly with reflective and transcendent themes, might facilitate mind-wandering and creative thinking. Neuroscientific studies suggest that self-transcendence is associated with the activation of the DMN (Travis et al., 2010; Travis & Shear, 2010; see; Travis & Parim, 2017), a brain network integral to self-reflective and internally directed processes (Gusnard et al., 2001; Soto et al., 2018). Considering the established connection between DMN activation and mind-wandering (Andrews-Hanna et al., 2014; Christoff et al., 2009; Mason et al., 2007), poems with reflective themes and the ability to evoke self-referential processing (Northoff et al., 2006; Qin & Northoff, 2011; van der Meer et al., 2010), were selected as appropriate stimuli in the study's context.

To select the experimental stimulus for the incubation task, an online pilot study was conducted via Qualtrics using five experimenter-selected English poems: "The Road Not Taken" (Robert Frost), "A Psalm of Life" and "The Builders" (Henry Wadsworth Longfellow), "The Mistake" (James Fenton), and "If" (Rudyard Kipling). These poems were selected based on their themes of life and experience, their potential to evoke self-relatedness, stimulate imagination and convey transcendence, as well as their moderate length (20–40 lines). In addition, semantic diversity ($M = 0.78$, $SD = 0.02$), measured by divergent semantic integration (DSI: Johnson et al., 2022) and lexical diversity ($M = 0.66$, $SD = 0.05$), assessed using the type-token ratio method (McCarthy & Jarvis, 2010), were applied as selection criteria to ensure the poems were comparable in linguistic richness and conceptual breadth. From

this pool, one poem was identified as the most suitable stimulus for the study.

We recruited 100 participants ($N = 100$; 43 males, 54 females, 3 non-binary/third gender, and 1 undisclosed), divided into five conditions of 20. Participants in each condition read one poem for 3 min and rated their experience on a 7-point Likert scale (1=strongly disagree to 7=strongly agree) in response to three following statements: (i) “I was able to connect myself with the poem” (self-connectedness; Cohen, 2018), (ii) “I was able to imagine diverse situations” (imagination; Green & Brock, 2000), and (iii) “I forgot that I was in the middle of an experiment” (transcendence; Busselle & Bilandzic, 2009). The poem titled “If” by Rudyard Kipling received the highest ratings in all three dimensions and was selected as the experimental stimulus for the main study. Details of the stimulus selection are available in the Open Science Framework (OSF) repository: (https://osf.io/gcx7s/?view_only=ffa01200343b47d988567a230a85e81a).

Participants

Using G*Power software (version 3.1; Faul et al., 2007), we calculated that a minimum sample size of 42 participants was required for an 80% power to detect a medium effect size (partial eta squared, $\eta_p^2 = 0.05$) with $\alpha = 0.05$, for three conditions and two measurements (pre/post). To ensure sufficient power, we recruited 153 participants (51 per condition) through Prolific. Inclusion criteria included a Prolific approval rating of 90% or above and fluency in English. Participants were randomly assigned to one of the three conditions: poetry reading condition ($N = 51$, 37 females, mean age \pm SD: 29.35 ± 7.16 years), poetry rating condition ($N = 51$, 35 females, mean age \pm SD: 29.19 ± 7.21 years), and control condition ($N = 51$, 34 females, mean age \pm SD: 30.75 ± 8.17 years). Participants received £3.50 at a rate of £7 per hour. The study protocol was approved by the Local Ethics Committee of the Department of Psychology at Goldsmiths, University of London.

Procedure

Baseline creativity tasks

Participants first completed two creativity tasks: Forward Flow (FF, Gray et al., 2019), and Alternate Uses Task (AUT, Guilford, 1967). The FF task measures associative thinking by asking participants to generate a chain of 19 words starting from a given seed word. The AUT measures divergent thinking by asking

participants to list as many creative uses as possible for a given object within 3 min.

The FF was chosen because creativity often involves exploring semantic memory networks, with highly creative individuals making broader associations and shifts between semantic categories (Beaty & Kenett, 2023). The FF is based on Mednick’s associative theory of creativity (Mednick, 1962), which suggests that creative thinking involves linking distant concepts within semantic memory (Kenett & Faust, 2019; Kenett, 2019; see also Beaty et al., 2021). This metric, using latent semantic analysis (Deerwester et al., 1990) to capture the semantic evolution of thoughts over time (Gray et al., 2019), quantifies the forward motion of naturalistic thought and is suggested by research to be correlated with creativity (Gray et al., 2019). Specifically, FF captures the semantic departure from previous thoughts during free association, providing insight into dynamic cognitive processes (Gray et al., 2019; Marron et al., 2018), making it a suitable choice for assessing the influence of poetry on creative thinking.

The AUT was chosen as a measure of divergent thinking as it has been a well-established indicator of creativity (Baer, 2014; Runco & Acar, 2012) and its ability to reliably demonstrate incubation effects, as highlighted by prior research (Baird et al., 2012; Ellwood et al., 2009; Sio & Ormerod, 2009). The AUT responses are usually scored for fluency (total number of responses) and originality (creative quality of responses) (Beaty & Johnson, 2021; Dumas & Dunbar, 2014; Silvia et al., 2008).

For the FF task, we used three seed words: “Sun” (the repeated-exposure word across pre- and post-incubation periods), “Bread” (word during pre-incubation), and “Towel” (word during post-incubation). Similarly, for the AUT, three objects were used: “Book” (the repeated-exposure object across pre- and post-incubation), “Jar” (object during pre-incubation), and “Hat” (object during post-incubation). Originality scoring of the AUT responses was computed using *SemDis*, an open platform for computing automated scoring of verbal creativity (Beaty & Johnson, 2021), which employs a semantic distance computing approach. Of note, the second seed word in the FF task (“Bread”) and the second object for the AUT task (“Jar”), both presented in the pre-incubation period but were not repeated in the post-incubation period, were compared to new words “Towel” in the FF and “Hat” in the AUT tasks in the post-incubation period, respectively, to evaluate whether taking a break alone, without incubation, could influence creative thinking, serving as a control analysis.

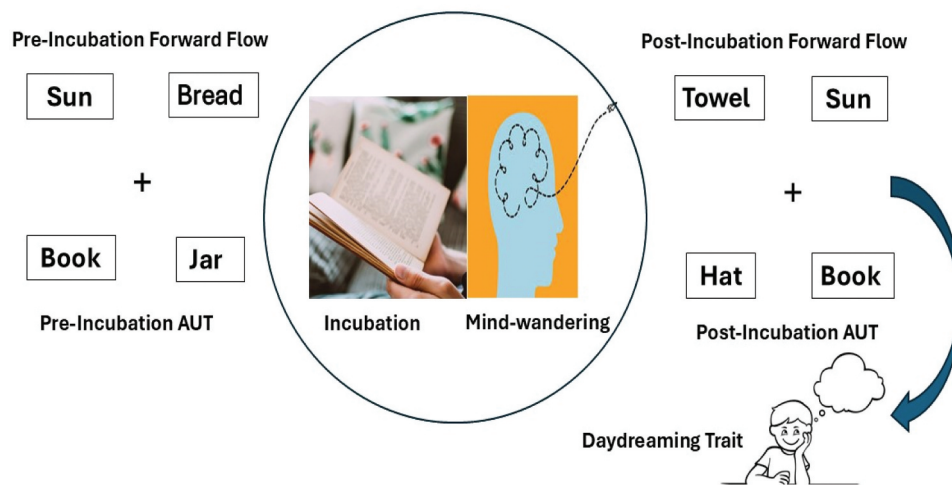


Figure 1. Overview of the experimental design showing pre- and post-incubation tasks for both Forward Flow (FF) and Alternate Uses Task (AUT), with incubation and an assessment of state mind-wandering and daydreaming traits.

The words selected for the Forward Flow problems had high imageability scores (639, 619, and 570, respectively) as determined by the MRC psycholinguistic database (Coltheart, 1981). High imageability words were chosen based on evidence linking imageability to enhanced semantic processing (Reilly & Kean, 2007) and the generation of vivid internal mental imagery (Gerwien et al., 2023). Additionally, high imageability has been shown to improve associative functions of the hippocampus, facilitating superior association-memory (Caplan & Madan, 2016), making such words particularly suitable for tasks requiring associative creativity. The objects selected for the AUT problems had high concreteness scores (4.90, 5.00, and 4.88, respectively) (Brysbaert et al., 2014). Words with high concreteness were chosen based on psycholinguistic evidence suggesting that concrete nouns, compared to abstract nouns, facilitate faster lexical decision performance and superior recall (Paivio, 1991; Papagno et al., 2009).

Incubation. After completing the baseline creativity tasks, participants engaged in an interpolated task period for 3 min. Three experimental conditions during this period were: a reading condition, a rating condition, and a control condition. In the reading condition, participants read and contemplated a poem (“If” by Rudyard Kipling). In the rating condition, participants read the same poem but were additionally asked to evaluate it on three constructs: aesthetic appeal, vivid imagery, and self-relatedness, using a 3-point scale (low to high), making this condition presumably more cognitively engaging than the poem-reading-only condition. In the control condition, participants read a non-poetic English text of a similar length to the poem but devoid of emotive words or expressions.

Immediately following the interpolated task, participants assessed their state of mind-wandering using the commonly used self-report measure, the Dundee Stress State Questionnaire (DSSQ) (Matthews et al., 2013). The DSSQ assessed task engagement, including how often participants’ determination and attention strayed from the task and how frequently they were preoccupied with worries, such as reflecting on past events and personal concerns (rating scale from 1 to 5, with higher scores indicating higher levels of mind-wandering).

Post-incubation creativity tasks. Following the incubation period, participants revisited the creativity tasks, both FF and AUT, solving both repeated-exposure problems and new-exposure problems. This design allowed for the evaluation of incubation effects, non-incubation effects, and general break effects.

Assessing trait daydreaming: the tendency to mind-wander. Finally, participants completed the 12-item Daydreaming Frequency subscale of the Imaginal Process Inventory (IPI) (Singer & Antrobus, 1972; see also Giambra, 1993), which measures individuals’ general tendency to engage in mind-wandering. Responses were rated on a 1–5 scale, with higher scores indicating greater daydreaming frequency. Daydreaming was explained to participants as an unintended, spontaneous shift of attention during work, involving thoughts unrelated to the task at hand (Giambra, 1993). In addition, participants provided demographic information, including gender, age, educational qualifications, liking of poetry, years of association with poetry, and poetry-writing habits. Figure 1 outlines the experimental design.

Data analysis

Initially, each group consisted of 51 participants. However, exclusions were made based on the task responses to ensure data quality. In the reading group, 3 participants were excluded due to repeated responses (e.g., using the same word or rhyming words) in the pre- or post-incubation tasks. In the rating group, 2 participants were excluded for repeated responses, and 1 for no response. In the control group, 1 participant was excluded for repeated responses in both tasks. After these exclusions, the final sample is as follows: Reading condition ($N = 48$, female = 35, mean \pm s.d. age: 29.58 ± 7.30 years), rating condition ($N = 48$, female = 33, mean \pm SD age: 29.23 ± 7.38 years), and the control condition ($N = 50$, female = 34, mean \pm s.d. age: 30.92 ± 8.16 years).

Participants were categorized into high and low state mind-wandering groups using a median split of their state mind-wandering scores within each condition. This approach was chosen for its simplicity, enabling clear categorization of participants into relatively higher and lower levels of mind-wandering, which facilitates clear comparisons both within and across experimental conditions. The median split approach is commonly used in prior research (Chaieb et al., 2020; Liu et al., 2023), due to its ease of interpretation and ability to create distinct groups (Iacobucci et al., 2015a). However, we acknowledge its limitations, including the potential loss of nuanced information that a continuous measure might better capture and a possible reduction in statistical power due to the dichotomization of a naturally continuous variable (Iacobucci et al., 2015b; Maxwell & Delaney, 1993). A similar approach was applied to the trait daydreaming scores, where participants were categorized into high and low daydreaming groups.

We employed the open-access online tool (<http://www.forwardflow.org/>, Gray et al., 2019) for the FF scoring. The FF score for a given seed word was calculated as the average semantic distance between each new thought and all previous thoughts generated by the participant for that seed word. The originality of AUT responses was assessed using SemDis (<http://semdis.wlu.psu.edu/>; Beaty & Johnson, 2021), an automated computational method that employs natural language processing to measure semantic relatedness. We selected the “Remove Filler and Clean” option to preprocess the AUT responses by removing special characters, numbers, and filler or stop words (e.g., *a*, *the*, *is*, *and*, *also*). The multiplicative compositional model was selected because

the responses contained more than one word. In contrast to the additive model, which simply sums the word vectors, this model combines word vectors by taking the product of all word vectors. Further, research suggests this approach aligns best with human ratings of relatedness and creativity (Beaty & Johnson, 2021; Mitchell & Lapata, 2010). For each response, mean SemDis scores were calculated across five semantic spaces: cbowukwac, cbowsubtitle (Mandera et al., 2017), cbowBNC (Baroni et al., 2014), GLoVe (Pennington et al., 2014), and TASA (Günther et al., 2019; Prabhakaran et al., 2014; see also Beaty & Johnson, 2021). These scores were then averaged across all responses in a specific AUT task for each participant. We chose Mean SemDis because it is not influenced by sample size or variability and provides absolute scores that are consistent across datasets, with a fixed range of 0 to 2, ensuring straightforward interpretation (Beaty & Johnson, 2021).

Improvement percentages for the creativity tasks were calculated separately for each problem type (repeated exposure, new exposure) using the formula [Improvement (%) = (post-incubation score – pre-incubation baseline score)/(pre-incubation baseline score)] \times 100 (Baird et al., 2012; Cai et al., 2009). A mixed 2×3 ANOVA was conducted to analyze repeated- and new-exposure problems separately for both FF and AUT. The independent variables were condition (3 levels: reading, rating, and control), and mind-wandering group (2 levels: high, low); the dependent variable was improvement percentage. The analysis of repeated-exposure problems assessed incubation effects, while the analysis of new-exposure problems assessed general creative enhancement. Additionally, a one-way ANOVA was conducted to examine the impact of the break (independent of incubation condition) on improvement percentage using new words presented before and after the break period. This analysis aimed to understand whether psychological states, like mood and arousal, might influence creativity, independently of mind-wandering, serving as a control.

Finally, a correlational analysis was conducted between the Daydreaming Frequency subscale scores from the IPI and the improvement percentage to examine whether individuals with a higher tendency to mind-wander in their daily lives exhibited greater creativity gains out of incubation. All statistical analyses were conducted using Jamovi (The jamovi project (2024), version 2.5) and IBM SPSS Statistics (version 27.0; IBM Corp, 2020).

Results

Mind wandering across conditions

Given the borderline result of Levene's test for homogeneity of variances, $F(2, 143) = 3.05, p = .05$, and to ensure robustness, Welch's ANOVA was conducted. Results indicated no significant differences, $F(1, 94) = 0.10, p = .751, \eta_p^2 = 0.001$, in mind-wandering scores between the poetry reading group ($M = 2.11, SD = 0.83$) and the poetry rating group ($M = 2.16, SD = 0.60$). Additionally, a comparison among the poetry reading-only, poetry rating, and control conditions ($M = 1.99, SD = 0.79$) revealed no significant group differences in participants' mind-wandering scores, $F(2, 93.42) = 0.70, p = .501, \eta_p^2 = 0.015$. These findings did not support our initial prediction that the poetry reading-only group would report higher levels of mind-wandering compared to the poetry rating group, which was presumed to be more cognitively demanding.

Analyses on creative task performances

Creativity task performance was analyzed using a $3 \times 2 \times 2$ mixed-ANOVA with session (pre-incubation, post-incubation) as a repeated measures factor and group condition (reading, rating, control) and state mind-wandering (high, low) as between-subjects factors. The analysis of FF scores revealed a significant interaction between session and mind-wandering, $F(1, 140) = 5.01, p = .027, \eta_p^2 = .03$, as well as a significant interaction between group condition, mind-wandering and session, $F(2, 140) = 3.27, p = .041, \eta_p^2 = .04$ (Figure 2). These interactions suggested differential effects of group condition and mind-wandering on associative creativity. No significant effects were observed on AUT scores ($p > .18, n.s.$). To further explore these effects, we conducted 2-way ANOVAs separately for repeated-exposure and new-exposure problems.

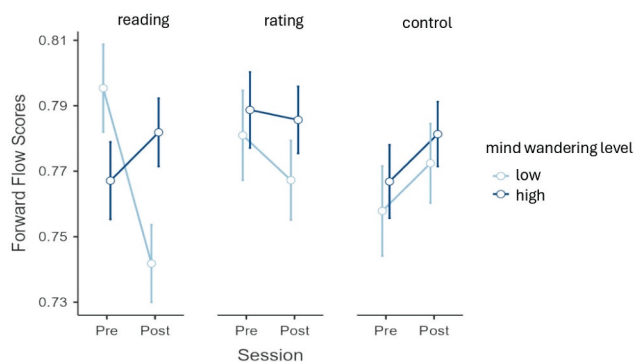


Figure 2. Estimated marginal means of pre- and post-incubation forward flow scores across three conditions for high and low state mind-wandering. Error bars represent standard errors.

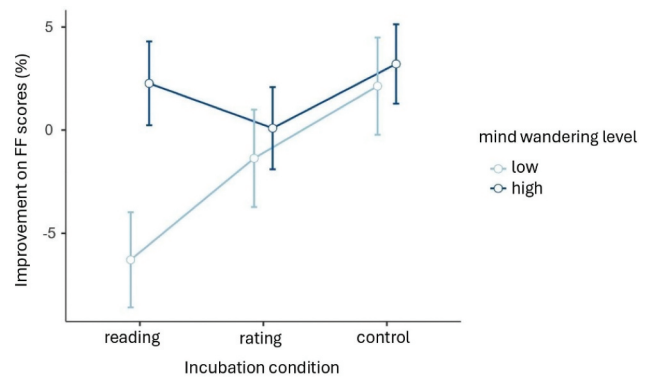


Figure 3. Improvement in forward flow (FF) scores (post incubation performance relative to baseline performance) for repeated-exposure problems. Error bars indicate standard errors of the mean.

Repeated-exposure condition

For repeated-exposure FF, a significant main effect of mind-wandering was observed, $F(1, 140) = 4.35, p = .039, \eta_p^2 = .03$, (Figure 3). Participants in the poetry reading condition with high levels of mind-wandering showed significantly greater improvements in their post-incubation FF scores compared to those with low mind-wandering (mean difference = 8.55, $p = .002$). However, the main effect of group condition, $F(2, 140) = 2.48, p = .088, \eta_p^2 = .03$, and the interaction effect between group condition and mind-wandering, $F(2, 140) = 1.88, p = .156, \eta_p^2 = .03$, were not significant.

For repeated-exposure AUT problems, no significant effects of group condition, $F(2, 139) = 1.61, p = .204, \eta_p^2 = .02$, mind wandering, $F(1, 139) = 2.25, p = .136, \eta_p^2 = .02$, or their interaction, $F(2, 139) = 0.18, p = .837, \eta_p^2 = .00$ were observed.

New-exposure condition

For new-exposure FF problems, no significant effects of group condition, $F(2, 140) = 2.49, p = .087, \eta_p^2 = .03$, mind-wandering, $F(1, 140) = 0.41, p = .524, \eta_p^2 = .00$, or their interaction, $F(2, 140) = 2.27, p = .107, \eta_p^2 = .03$, were found, suggesting no incubation effects for new-exposure problems.

AUT fluency

For the repeated-exposure AUT problem, fluency improvement scores differed significantly between group conditions, $F(2, 139) = 4.77, p = .01, \eta_p^2 = .06$. Post-hoc analysis with Bonferroni correction revealed that the reading condition showed significantly greater improvement compared to the rating condition (mean difference = 23.09, $p = .021$); however, no significant

Table 1. Bivariate correlations between Daydreaming Frequency subscale (DDFS) scores and the improvement (%) on repeated and new exposure for FF and the AUT.

	1	2	3	4	5
1. Improv_RepExp_FF	-				
2. Improv_NewExp_FF	0.69***	-			
3. Improv_RepExp_AUT	-0.01	-0.06	-		
4. Improv_NewExp_AUT	-0.05	0.04	0.48***	-	
5. DDFS scores	0.11	-0.01	0.02	0.01	-

* $p < .05$, ** $p < .01$, *** $p < .001$.

differences were found between reading and control conditions ($p > .9$, n.s.). Additionally, the rating condition had significantly lower fluency improvement than the control condition (mean difference = -21.96 , $p = .03$). There was no significant main effect of state mind-wandering, $F(1, 139) = 0.36$, $p = .55$, $\eta_p^2 = .00$ or a significant interaction between group condition and state mind-wandering, $F(2, 139) = 0.05$, $p = .95$, $\eta_p^2 = .00$.

Individual differences in mind wandering: daydreaming trait

Scores on the Daydreaming Frequency subscale of the IPI were not positively correlated with improvements in FF or AUT scores for either repeated- or new-exposure problems (Table 1).

Impact of break on creativity

A one-way ANOVAs examining the impact of the break (independent of incubation) on creativity improvements using new words presented before and after the break period revealed no statistically significant differences across groups for FF, $F(2, 91.79) = 1.27$, $p = .287$; AUT: $F(2, 93.50) = 0.49$, $p = .612$.

Discussion

The present study explored whether reading poetry during a break from problem-solving could serve as an effective incubation task for enhancing creativity. While previous research supports the idea that creative incubation, characterized by breaks from focused problem-solving, can enhance creative thinking (Baird et al., 2012; Browne & Cruse, 1988; Patrick, 1986; Segal, 2004), its cognitive mechanisms remain underexplored when these breaks involve literary activities like reading poetry. Our findings reported the potential of poetry reading, particularly when associated with high levels of state mind wandering, may enhance associative creativity as assessed by the Forward Flow (FF) task (Beaty & Kenett, 2023; Kenett & Faust, 2019; Kenett, 2019; see also Beaty et al., 2021). However, no significant effect of

poetry reading was observed on divergent thinking, as measured by the Alternate Uses Task (AUT).

The participants in the poetry reading condition who reported high levels of state mind-wandering exhibited significant improvements in FF scores, specifically to repeated-exposure problems. These improvements support the notion that incubation allows unconscious or indirect cognitive processes to operate, enabling fresh insights upon re-engagement with a problem (Baird et al., 2012). The absence of improvement in new-exposure problems suggests that the observed effects are attributable to incubation rather than a general enhancement in creative problem-solving (Baird et al., 2012). However, the lack of a significant interaction between group condition and mind-wandering suggests that the influence of mind-wandering on FF improvements was not uniquely associated with the type of incubation task. This aligns with the finding that the three group conditions did not significantly differ in mind-wandering scores. Consequently, while high levels of mind-wandering during poetry reading appeared to enhance associative thinking, this study does not explicitly demonstrate that poetry reading uniquely facilitates creative incubation (Baird et al., 2012; Christoff et al., 2011; Tan et al., 2015; Yamaoka & Yukawa, 2016). Instead, the poetry-reading condition revealed a notable trend favoring high mind-wanderers, suggesting that mind-wandering associated with poetry reading during a break may enhance associative processes for addressing previously encountered problems.

Notably, and in contrast to prior research linking incubation to improvements in divergent thinking (Baird et al., 2012), the present study did not find evidence that incubation facilitated divergent thinking, which involves the generation of novel, out-of-the-box ideas. We attribute this difference to key methodological differences, particularly in the structure and conceptualization of the interpolated tasks during the incubation period. Baird et al. (2012) explicitly categorized tasks as demanding (e.g., 1-back task) or undemanding (e.g., 0-back task). Undemanding tasks were shown earlier to elicit greater mind-wandering due to their minimal cognitive demands (Sio & Ormerod, 2009; Mason et al., 2007; Smallwood et al.,

2009; see; Baird et al., 2012). The study by Baird et al. (2012) demonstrated significant group-level differences in mind-wandering across incubation conditions (demanding vs. undemanding), replicating previous findings that high cognitive demands reduce mind-wandering (Sio & Ormerod, 2009). In contrast, our study did not explicitly categorize the reading tasks (poetry or non-poetic texts) based on their cognitive demands. Instead, our primary aim was to explore the potential of poetry reading as a unique form of incubation, focusing on its ability to facilitate creative thinking. This design choice reflects a novel perspective, and our findings suggest that poetry reading, particularly when paired with high levels of mind-wandering, may facilitate creative incubation for associative creativity but not for divergent thinking. This conclusion is supported by selective improvements of associative thinking observed in particularly repeated exposure problems, as opposed to new-exposure problems, affirming that these effects stem from incubation rather than general improvements in creative problem-solving performance.

Divergent thinking tasks, such as the AUT, require external focus and attentional shifts, which may contrast with the immersive and inwardly directed nature of poetry reading. This may explain why poetry reading facilitated associative creativity but did not significantly improve divergent thinking performance. Additionally, individual differences in participants' responses to the poems, coupled with potential constraints imposed by the duration of the incubation period, may have influenced these outcomes. Further, the interpolated reading tasks in our study may have required higher cognitive engagement than undemanding tasks like 0-back, potentially limiting the extent to which participants disengaged from prior problems and allowing only partial recovery from cognitive fixation. Finally, individual differences in how participants interacted with the poetry stimuli might have also played a role. For example, variability in self-referential processing or emotional engagement with the poems could have created heterogeneity in the observed outcomes, potentially diluting the effects on divergent thinking at a group level.

Moreover, while this study utilized established automated scoring methods to evaluate the originality of the AUT responses, incorporating human evaluations could provide additional insights into aspects such as relevance and depth of creativity, which may not be fully captured by automated measures. Combining human ratings with automated metrics could offer a more holistic assessment of divergent thinking, thereby increasing the reliability and validity of AUT scores. Future

research should consider integrating both approaches for a more thorough evaluation of originality.

Interestingly, our findings revealed significant group-level differences in repeated-exposure AUT fluency improvement. Ideational fluency, defined as the ability to generate a large number of responses (Hocevar, 1979), and operationalized as the count of relevant responses in a divergent thinking task (DT), serves as "the backbone of classic DT scoring" (Silvia et al., 2013). Research highlights that ideational fluency reflects a close relationship between associative and divergent thinking abilities (Benedek et al., 2012). Thus, our findings on significant incubation condition-level differences in AUT fluency improvement for repeated exposure problem strengthens the potential of poetry-reading as incubation tasks to influence associative thought processes. However, while the incubation conditions in this study facilitated the quantity of ideational responses, they did not effectively improve the originality (quality) of these responses, suggesting that they were not strictly effective in enhancing overall creative ideation.

Notably, the impact of the break (independent of incubation) on creativity score improvements, as measured by new words presented before and after the break, revealed no statistically significant differences across groups. This points out the relevance of state mind-wandering associated with incubation tasks in facilitating creativity. In contrast, a simple break involving poetry reading – potentially influenced by other psychological states like mood or arousal – may not effectively enhance either associative or divergent thinking in readers. Future exploration could examine the roles of mood, arousal, and other psychological states during such breaks, independent of incubation paradigm.

Finally, this study did not find evidence for a correlation between individual differences in mind-wandering (i.e., trait daydreaming) and creativity, which rules out the notion that individuals who mind-wander more frequently in their daily lives may be more creative in general (Baird et al., 2012). This finding strengthens our findings that the incubation conditions were specifically associated with a wandering mind which strictly linked to the incubation tasks; dispositional trait of mind wandering in the individuals did not come to play. However, while this study focused on state and dispositional mind-wandering, other factors that may influence the observed relationship were not measured. Prior research suggests that individual differences in motivation, task interest, and task experience correlate with mind-wandering during reading tasks (Robison & Unsworth, 2015; Unsworth & McMillan, 2013). Future

research could explore the individual difference measures to better understand the complex relationship between mind-wandering and creativity.

Further, based on prior research showing that mind-wandering impairs comprehension during reading (Dixon & Bortolussi, 2013; Feng et al., 2013; Franklin et al., 2011; see; Smallwood & Schooler, 2015), the focus on reading tasks during incubation in this study may have inadvertently constrained the role of mind-wandering. This could explain why the findings did not replicate prior incubation studies (Sio & Ormerod, 2009; Mason et al., 2007; Smallwood et al., 2009; see; Baird et al., 2012) that used tasks with lower cognitive demands. Moreover, given that mind-wandering is associated with poor performance on cognitively demanding tasks requiring executive control (Mrazek et al., 2012; see; Smallwood & Schooler, 2015), it is plausible that the comprehension demands of poetry reading imposed a higher cognitive load, limiting opportunities for mind-wandering. This may have impeded the incubation effect typically observed in less demanding tasks, such as the 0-back condition in earlier studies (Baird et al., 2012). Future research should carefully differentiate between cognitively engaging and less engaging poetry or text stimuli, with measured differences in cognitive demands, to better explore their effects on creativity.

Conclusion

The present study highlights poetry reading as a promising incubation task for boosting associative creativity, particularly when accompanied by higher levels of mind wandering. While poetry reading improved the naturalistic flow of thought processes, it did not significantly enhance the generation of novel ideas. Thus, while this study does not provide definitive evidence that poetry reading inherently enhances creativity, it highlights the broader role of mind-wandering in creative problem-solving, aligning with prior research (Baird et al., 2012; Gilhooly et al., 2012; Ruby et al., 2013; Sio & Ormerod, 2009; Yamaoka & Yukawa, 2016). From a theoretical perspective, the findings suggest that taking a break with a seemingly unrelated and relaxing task, such as reading poetry, can facilitate associative creativity, offering valuable insights into how incubation periods can support the flow of creative thought. This insight advances our understanding of how incubation periods can optimize creative process. The study also emphasizes the importance of considering both the cognitive load of interpolated tasks and the role of mind-wandering in influencing creative thinking. Specifically, tasks that balance cognitive engagement

with opportunities for spontaneous thought may be particularly effective in enhancing associative creativity. Future research could employ more rigorously defined incubation paradigms to further explore poetry's potential as a catalyst for creative thinking.

On a lighter note, in an increasingly distracted world, poetry offers a unique and subtle way to allow the mind to wander and uncover surprising connections within the landscape of our thoughts. While it may not always spark entirely new ideas, its true power might lie in enriching the associative pathways of existing ideas. So, the next time you take a break, consider dipping into poetry – it might just lead you to unexpected creative insights!

Disclosure statement

No potential conflict of interest was reported by the author(s).

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Data availability statement

The data and codes that support the findings of this study are openly available in the Open Science Framework (OSF) repository at https://osf.io/gcx7s/?view_only=ffa01200343b47d988567a230a85e81a

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