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Ideasthetic Imagining – Mapping the Brain's Microstates using Magnetoencephalography (MEG)

Abstract:

This contribution focuses on an exploratory study, titled 'Ideasthetic Imagining – Mapping the Brain's Microstates using Magnetoencephalography (MEG)', conducted at Swinburne University of Technology (2023: Melbourne, Australia). The study investigates neural activity in participants' brains while undertaking a creative writing workshop. Participants write imaginatively from short- and long-term memory. We utilise MEG neuroimaging technology to determine where and how the brain is processing information at distinct stages of the workshop. The creative writing workshop at the heart of the study involves imaginative approaches to life writing, transforming unresolved memories through creative practice. As participants engage in the workshop, activity in target regions of the brain is measured. The researchers then analyse the interaction between distinct regions of the brain at different stages of the workshop – at primary moments of narrative composition and beyond. The research provides fundamental insights into human intelligence and the neural basis of creative cognition. Understanding cognitive processes that occur in various regions of the brain during the workshop contributes objective evidence about how we might utilise creative writing practices to facilitate future-mindedness. The research team are considering tailored expansion of the creative writing workshop for the health|wellbeing and education spheres.

Biographical note:

Julia lives in Melbourne, Australia, on unceded Wurundjeri land. Her novel, *The Earth Does Not Get Fat* (2018) was longlisted for the Indie Book Awards (debut fiction). *Bloodrust and Other Stories* was published in 2022 (fiction of the week: SMH and The Age newspapers). *Blent* (a novella) was published in 2025. Julia is a practice-led researcher drawn towards neuro-psychoanalytic approaches to creative writing. She is President|Chair of the Australasian Association of Writing Programs (AAWP), the peak academic body representing the discipline of Creative Writing (Australasia), and Associate Professor|Discipline Leader (Creative Writing, Literature and Publishing) at Swinburne University, Melbourne.

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Paris Lyons is an interdisciplinary researcher, consultant and artist, and the founder of the Science Art Network. She holds an Honours degree in Psychology and has worked across neuroscience research – from theoretical inquiry to neuroimaging infrastructure – as a former MEG technician and Operations Manager at Swinburne Neuroimaging. Paris now primarily consults on critical infrastructure projects in developing Pacific Nations, guided by a belief in the deep interconnectedness of disciplines and a commitment to meaningful, humanitarian impact through systems thinking and collaboration.

Keywords:
creative writing, neuroimaging, neuro|psychoanalysis, magnetoencephalography, empathy

Introduction

This contribution focuses on an exploratory study titled 'Ideasthetic Imagining – Mapping the Brain's Microstates using Magnetoencephalography (MEG)', conducted at Swinburne University of Technology (Prendergast, Slade & Lyons, 2023). The study investigates the activity in participants' brains while undertaking a creative writing workshop where they write imaginatively from short- and long-term memory. We utilise MEG neuroimaging technology to determine where and how the brain is processing information during distinct stages of the workshop.

This research is premised upon neuro|psychoanalytic approaches to writing and creativity. The working hypothesis for the exploratory study is outlined in a number of recently published articles, including (but not limited to) those examining the following topics: the relationship between realist writing and reality; stimulus in creative writing; and creative writing as it relates to processes of remembering and dreaming (see, for example: Prendergast, 2022a; 2022b; 2023). This body of research engages with creative writing as a process of working through conundrum and contradiction, drawing attention to the way 'story-work' surfaces associative dreams and memories, and reflecting upon the way creative practice may expose experiential knowledge that did not otherwise seem known, let alone 'fetchable'.

The creative writing workshop is premised upon practice-led research – the approach is underpinned by a writer's reflections on the impact of practice on the mind, and the influence of the mind's eye on practice. As researchers, we take an interest in the ramifications of deep, sensory imagining as it relates to our engagement with the past, including preconscious memories and mental processes. We are interested in how these memories and processes can be inhibited and thus, on the one hand, prevented from becoming conscious and, on the other hand, encouraged. More broadly, we reflect upon the impact of imaginative processes on one's attitude of mind, considering the way these practices might inform transdisciplinary approaches to wellbeing and, in particular, future-mindedness.

The creative writing workshop arises from reflecting upon creative writing practice as a response to an unresolved idea or experience – a state of conundrum and contradiction at the level of idea – that is, something one is troubled by, something one doesn't understand or would like to understand more fully. At a primary moment of narrative composition, creative writing often begins with an imbalance between the idea, in philosophical terms, and aesthesia: one's sensate response to conundrum and contradiction. In fact, the philosophical themes may only be fully available in retrospect. Writing creatively may, therefore, represent a form of problem-finding and (potentially) problem-solving: an attempt to strike a balance between idea and aesthesia, moving beyond a sense of being 'affectively overthrown' through a narrativised version of the underlying ideas.

The creative writing workshop requires participants to write creatively in response to incomplete or unresolved memories, and is administered in two stages that each involve three distinct exercises. Stage One focuses on a long-term, autobiographical memory. Stage Two

focuses on a short-term, working memory. The microstates of participants' brains are recorded across each of the three workshop exercises, measuring the brain activity involved in processes of deep, sensory imagining. The workshop outputs include life writing artefacts (broadly conceived): memory-infused writing, fiction and creative non-fiction. The generated outputs represent the lead chief investigator's ongoing reflection upon practice: book-length creative publications informed by her engagement with realist writing. Prendergast employs the term realism [1] within her conception of the operations of what she has come to call narrative lyricism [2], describing narrative lyricism as a form of realism which aims to capture what it feels like to move through the world. The workshop thereby replicates the sustained processes of a practising writer and is designed to capture the activity in specific regions of the brain, as well as the connectivity between brain regions at distinct stages of the workshop. The scope of the current article is delimited to contrast analysis in target regions of the brain, as data analysis of neural networks is ongoing.

To contextualise our research approach, we note Prendergast's ongoing pairing of two theories: ideasthesia, or "sensing concepts", from neuroscience (Nikolić, 2016, p. 2), and the "unthought known" from psychoanalysis (Bollas, 2014; 2017). Prendergast pays attention to the way she employs sensory imagining – that is, imagining informed by pre-conscious memories and mental processes – when writing and reading (see, for example: Prendergast, 2022a; 2022b). This research is premised upon her understanding of sensation and thought as being tightly intertwined, and is indicative of her abiding interest in memory as a fertile repository that informs narrative composition at key moments. Prendergast's methods represent a neuro|psychoanalytic approach to writing and creativity as a practice-led response to the question of where story material comes from.

The exploratory study affords an opportunity for fully integrated interdisciplinary work from the fields of creative writing and neuroscience. It opens possibilities for future research by offering a framework for mapping the internalised and mute processes and practices involved in writing creatively and using autobiographical memory as the primary stimuli. We recognise that, while writers may be acutely aware of the impact of practice on wellbeing and future-mindedness, there is scant research supporting claims of efficacy and little insight regarding the actual benefits of specific creative writing processes and practices; why these benefits occur; and how we might harness this knowledge for shaping practical workshops that target health|wellbeing and educational outcomes.

As the research team conducts primary data analysis, we note stark differences between the experimental group (practising writers) and the control group (non-writers). Contrasting brain activity during distinct stages of the workshops reveals that, when working from long-term memory, particular regions of the brain are activated to a far greater extent in the experimental group, when compared to the control group. We elaborate upon these findings under the subheading 'Preliminary findings: Creative writing processes and practice'. The significance of these findings, as they relate to opportunities for further research, are discussed under the subheading 'Conclusion: Opportunities for future research'. We preface this discussion by

providing some detail about the context for the study, and by discussing the ways in which our approach is informed by, and deviates from, existing studies.

Theoretical paradigms of the exploratory study: Ideasthesia and the unthought known

Theory one: Ideasthesia

Prendergast's practice-led approach to the concept of ideasthesia began in 2016, when neuroscientist Danko Nikolić wrote to her about one of her short stories. He emailed:

> I hope that you are the right Julia.
> I just read the story "Clay lips and love". I enjoyed it very much. Almost made me cry.
> Is it yours?
> Danko Nikolić. (Nikolić, personal communication, December 2016)

Nikolić's name was familiar to Prendergast because she had been reading about the concept of ideasthesia, developed by Nikolić, whose working definition of the concept is "sensing concepts" (Nikolić, 2016, p. 2). The theory arises from the "Ancient Greek word idea (for concept) and aesthesis (for sensation). Hence […] the term ideasthesia [or] sensing concepts" (p. 2). Ideasthesia was developed from the concept of synaesthesia. As Nikolić explains: "Synesthetes are people who have additional sensory-like experiences to a stimulus that otherwise would not induce such experiences" (p. 2). While the concept of ideasthesia had been explored from the perspective of a subject's experience of visual art – that is, a viewer's engagement with an artwork – Prendergast brought this concept to practice-led thinking by considering ideasthesia as it relates to creative writing processes and practices in general, and 'sensing ideas' as it relates to memory as the impetus for practice in particular. Prendergast asks how a writer plots concepts (ideas) as sensory data and how this reflects stimulus-induced acts (Prendergast, 2024). The exploratory study detailed here is premised upon this long-standing practice-led inquiry and incorporates the 'hard sciences' through fully integrated interdisciplinary work from the fields of creative writing and neuroscience.

Returning to their initial correspondence, Nikolić asked Prendergast the following provocative question:

> Could you possibly explain to me how you think [your story] relates to the theory of ideasthesia in art [….] For example, the theory proposes the 'rule' that the strongest aesthesia must be coupled with the strongest idea. Do you see that in your story? At which point? These are things that I am tremendously curious about. (Nikolić, personal correspondence, December, 2016)

As previously discussed, in the article 'Ideasthetic Imagining: Writing as Dream-membering' Prendergast (2022a) suggests that:

> The question of the relationship between aesthesia and idea raises the thorny, but fascinating, issue of how one determines the 'strength' of either. In everyday terms, one could imagine a very bright light that dominates the senses, but a rainbow-coloured border that engages our attention to a far greater extent. Which would be considered 'stronger'? (p. 4–5)

In recent months, the research team have been hypothesising about these kinds of questions:

> deepening [our] understanding of debates in psychology and neuroscience about terms such as 'salience' – the visual neuroscientists tend to want to associate salience with stimulus features, the cognitive folks to cost/reward functions, and the emotion scientists to affective strength. [… The research team is] firmly in the camp of the emotion scientists […] recognis[ing] that affect lies at the heart of [the] experience of stimulus-for and stimulus-in, in acts of narrative making. (Prendergast, 2022a, p. 4–5)

Collectively, the research team have strong interests in how emotions are perceived and processed, impacting upon our experiences of, and responses to, stimuli.

Overall, the practice-led research that underpins the study is premised upon the original concept of ideasthetic imagining. As the first researcher internationally to theorise the concept of ideasthesia from a practice-led perspective, Prendergast devised the concept of ideasthetic imagining to explicate the entwined nature of idea and senses in acts of narrative making. Prendergast's fixation upon what this term means in practice, and to practice, is evidenced by a number of articles focussing on that topic (see, for example: Prendergast, 2015; 2018; 2019; 2021; 2022a; 2023; & 2024). The most recent articles examining ideasthetic imagining as it relates to stimulus in general, and ideasthetic imagining as a trigger for acts of dream-membering in particular, represent a culmination point in Prendergast's scholarly research. While the concept of ideasthetic imagining reflects Prendergast's understanding of the motivational processes and practices that inform realist modes of creative writing, the exploratory study aims to examine brain activity of participants while actively engaged in creative writing practice, with a particular focus on memory as the primary stimulus.

Theory two: The Unthought Known

The exploratory study detailed in this article aims to account for brain activity phenomena in creative writing practice, with reference to Nikolić's top-down approach to "the explanatory gap between the brain and the mind", which "investigates behavior and experiences" (2020). The theory of ideasthesia is part of Nikolić's response to the "hard problem" of consciousness – a term first coined by David Chalmers, an Australian academic who practices in philosophy of mind and takes a particular interest in consciousness and "in philosophical issues about meaning and possibility" (Routledge, n.d.). Chalmers is interested in the:

> really hard problem of consciousness, [which is …] the problem of experience. When we think and perceive, there is a whir of information-processing, but there is also a subjective aspect. As Nagel (1974) has put it, there is *something it is like* to be a conscious organism. This subjective aspect is experience. (Chalmers, 1995, p. 2)

The research team is interested in how the writer's experience of "something it is like" informs the way we sense concepts in acts of narrative making. That is: how does creative practice prompt the author's phenomenological memory, bringing to consciousness unresolved autobiographical memories and triggering sensory engagement with memory as a springboard for imaginative storytelling?

In this way, the structure of the creative writing workshop is premised upon the perceived relationship between stimulus-for and stimulus-in creative writing in affect-driven processes. This discussion recognises that some forms of writing are informed, fundamentally and necessarily, by the subjective aspect of knowledge. Nikolić (2016) emphasises that this knowledge is "for the most part […] unconscious and hence not easy to describe in words" (p. 4). Conceptually, sensation is rooted in associations and is based upon 'phenomenal experience, also known as qualia. Sensations are about the way things [feel] and 'are like'. It is about the redness of a red colour and the sourness of a lime. Sensations make up our inner mental life and "light it up" so that life does not happen "in the dark"' (p. 5).

The exploratory study prompts 'qualia-tative' imagining. Springboarding from writing prompts employing long-term or short-term memory, participants document their experience of something it is like via the operational practices and processes of ideasthetic imagining. Simultaneously, the research team uses MEG capabilities to record participants' brain activity in distinct, time-stamped stages, as it correlates with specific exercises within each stage. In this way, the study attends to a question postulated by creative writing scholars Jen Webb and Donna Lee Brien in 'Addressing the 'Ancient Quarrel': Creative Writing as Research': "how can art ally with the rational domain that is science to produce what constitutes knowledge?" (Webb & Brien, 2011, p. 273). Webb and Brien suggest that "the insights generated by the sensate domain have their own validity, in knowledge terms, though we may not *yet* [emphasis added] be entirely clear about how the two domains intersect" (p. 274). As expanded upon elsewhere (see, Prendergast, 2022a), Webb and Brien extend John Dewey's century-old philosophising:

> Pretty much all students [of philosophy] are convinced that we can reduce knowledge neither to a set of associated sensations, nor yet to a purely rational system of relations of thought [….] Sensation and thought themselves seem to stand out more rigidly opposed to each other in their own natures than ever. Why both are necessary, and how two such opposed forces co-operate *in bringing about the unified result of knowledge* [emphasis added], becomes more and more of a mystery. (Dewey, 1972 [1897], p. 4–5)

Certainly, we see this study as being informed by our understanding of the relationship between the interrelated forces that underpin ideastheia: sensation and thought. Writing creatively leads to a practice-led understanding of the systems used to engage and manipulate thought, as well as of the way these systems overlap with those involved in sensory perception. We see our understanding of sensation and thought as tightly intertwined and this research as a means of investigating the experience of 'abstract' thought, in incremental stages.

Prendergast has previously postulated an association between ideasthetic acts of narrative making and the psychoanalytic relationship [3]. This thinking is outlined in numerous publications (see, for example, Prendergast, 2019; 2021). Theorising about the twin processes of stimulus-for and stimulus-in as paired activities of meta-cognition further develops Prendergast's (2021) understanding of Christopher Bollas's concept of the "unthought known"

(Bollas, 2014). Bollas postulates the unthought known as the primary repressed unconscious, a repository of experiential knowledge that may be recognised through the "immaterial intelligence of form" whereby "the analyst (like the artist) breaks the figure; not to find out what is inside but to realise the immaterial intelligence of form" (p. 19). Prendergast's iterative understanding of story-work as an imaginative act of narrative making represents the evolving artefact as an example of the immaterial intelligence of form – a 'reconstruction' of memory and experiential knowledge in the form of concrete and specific narrative detail.

The creative writing workshop at the heart of the study allows the researchers to map the brain's microstates as participants formulate ideas through the generation of a narrative. The creative writing responses are developed through intuitive – rather than premeditated or logically planned – acts of narrative making, employing memory as a springboard for acts of invention. The workshop is designed to capture the ways in which, as Webb and Brien (2011) suggest, writers "examine and 'imaginatively transfigure the real'" (p. 274). This provides an opportunity for us to examine the brain's processing of "felt presences" per Gordon Weaver's provocation: "in how small a space can [we] create the felt presences that animate successful stories" (in Shapard & Thomas, 1983, p. 228). This concept of felt presences is at the heart of the qualia-tative concept of ideasthetic imagining and is examined through this opportunity for determining the brain's microstates in the real-time processing of felt presences.

While a comprehensive discussion of the highly complex nature of memory is beyond the scope of this article, this discussion informs the theoretical paradigms of the exploratory study. An encompassing examination of memory as it informs practice is undertaken in the body of published research that informs the imperatives and the conscientious design of the study. The research considers how processes of ideasthetic imagining assists in understanding the relative strength of ideas and memories that have been neglected, repressed or dismissed – as well as how the inevitable inaccuracy of memory plays into the development of published works. A recently published article including the reflections of study participants (the experimental group: practising writers) adds to this discussion (Prendergast et al., 2025). Further analysis of participant experience informs opportunities for expansion of the research project, as outlined at 'Opportunities for future research'.

The research team acknowledges that working with unresolved memory risks triggering traumatic memories. The possibility that traumatic memories may arise represents significant challenges within the context of a workshop including exercises where participants are encouraged to write a memory from a perspective other than their own and, subsequently, to extend the remembered memory by including fictional detail.

The research team prioritises the necessity of creating a safe environment for writers and non-writer participants – ensuring they are informed about the scope of the creative workshop and the possibility that challenging memories and difficult narratives may arise. The Participant Information and Consent Form provides full details of the background and parameters of the study: (i) questionnaires and assessments (ii) MEG scan conducted while participants engage in a creative writing task, and (iii) MRI structural scan. Participants are informed about their

rights to withdraw from the study without question, at any stage, and offered access to support services should unforeseen challenges arise. The thorough and systematic interview session undertaken prior to the workshop ensures participants have understood the information provided to them. This session includes the completion of the Depression and Anxiety Scales (DASS) self-report assessment, together with other pre-session imperatives as approved during ethics review of the study. The opportunity to withdraw, as well as the availability of support services, is reiterated during the interview session. A full debriefing session is conducted at the conclusion of the creative writing workshop and MRI [4].

The exploratory study: How previous research informs the project design

Project design

This research identifies and fosters human intelligence by providing fundamental insights into the neural basis of creative cognition. Understanding cognitive processes that occur in various regions of the brain during the workshop contributes objective evidence about how we might utilise creative writing practices to foster future-mindedness.

The creative writing workshop embedded in the exploratory study takes imaginative approaches to life writing, transforming incomplete and unresolved memories through creative writing practice. Utilising processes of deep, sensory imagining, the workshop facilitates the generation of alternative perspectives and scenarios. As participants engage in the workshop, the research team measures activity in specified target regions of the brain. The workshop is structured in two clearly delineated stages: Stage One focuses on long-term autobiographical memory and Stage Two focuses on short-term memory. Each stage in the workshop involves three discrete exercises:

1. writing autobiographical memory
2. writing autobiographical memory from a perspective other than that of the participant
3. writing a fictionalised version of autobiographical memory (plotting alternate scenarios).

The research team are particularly interested in the regions of the brain associated with forms of embodied cognition: the processing of affective content; the integration of interoceptive information and emotional experience (such as socially driven interactions and empathy-related responses, divergent thinking tasks and metaphor production); episodic and semantic memory creation and recall; and self-referential integration. We are also interested in the dynamical changes to brain activity that characterise transitions from one type of cognitive process – sensory experiencing of memories, for example – to others, such as the forming of a new narrative.

We compare results from the experimental group (comprising practising writers) and the control group (comprising non-writers) as they undertake the three exercises contained within each stage of the workshop. Utilising advanced MEG neuroimaging methods, the research team

tracks the neural activity of participants at set time periods throughout the workshop. MEG is unique in that, as opposed to fMRI, brain activity is time-stamped. Data analysis includes beamform analysis of particular regions in the brain and connectivity analysis of the interactivity between networks of brain activity (noting this article is limited to the former: focusing the standout finding from primary contrast analysis). Data analysis software affords the successful separation of the regions of neural activity in both writing and non-writing participants; identification of patterns of activity that may allow for apportioning of participants as belonging to one group or the other; and analysis of how these patterns change as both writers and non-writers participate in the workshop. Importantly, this comparison further enhances our understanding of how such transitions can be facilitated.

In a review of the study, undertaken for the Swinburne University Human Research Ethics Committee (SUHREC) in 2021, Nikolić (2021) reflects, "I think that, from the data that they plan to acquire, it will be possible to create multiple scientific studies, each with an analysis focused on a different aspect of the data".

As suggested during peer review, the exploratory study findings suggest:

> profound implications for how all of us, neuroscientists and creative writers alike, experience and understand our minds working in tandem with our experience (in real time, memory, and imagination) to construct a world, people it, knit ourselves into it, and write about it, perhaps leading to the discovery of new forms and genres in the process. (Coles, 2025)

The workshop requires participants to write through the lens of a very specific focalising consciousness, and to imagine the scene ideasthetically. The researchers seek to leverage MEG results to reveal new insights about the activity of deep, sensory imagining in acts of narrative making. As participants bring (past) feeling to (present) thinking, utilising embodied knowledge to make something new, they expand their engagement with unresolved memory through two exercises: i) examining the scene of the memory from another perspective; and ii) plotting alternate outcomes.

In this way the creative writing workshop at the heart of the study is clearly focused on the practices of creative writers across a variety of mediums – a locus identified as a strength of the study design, in peer review:

> The power of this study for me is that the values of the creative writers are clearly reflected in the goals and the careful design of the study. The writers' control over the structure of the workshop and its prompts demonstrably strengthens the scientific results. The experimental work itself recognizes and capitalizes on the fact that the study of creative writing (prose and poetry) is the study of human cognition, especially as it engages memory of the past in the present to revise the future. […] The insights expressed in this paper are also important for creative writers interested in thinking about literary issues, practices, and operations as connected to the real-life experiences of the writer translating those experiences into form. (Coles, 2025)

Innovatively, the study deviates from the cognitive and goal-driven approaches of previous studies – understood to align with Linda Flower and John R. Hayes's 1981 study, 'A Cognitive Process Theory of Writing', which provides a comprehensive investigation and analysis of the question: "what guides the decisions writers make as they write?" (p. 365). Indeed, the creative writing workshop at the heart of our contemporary study is not focused on decision-making, per se, but on the relationship between idea and aesthesis in stimulus-induced acts – premised as it is upon the processes and practices involved in ideasthetic imagining. In this way, we pay particular attention to the way writers engage with autobiographical memory and employ associative processing – informed by experiential knowledge and mental processes – in order to re-envisage the original memory from an alternative perspective and build alternative fictional scenarios.

Key insights derived from comparable studies

In existing studies, functional brain activity associated with creative autobiographical writing is often investigated through analysis of specific brain regions in isolation (Fan et al., 2023). However, when writers generate written responses to autobiographical memory, various regions of the brain are activated simultaneously rather than in isolation. Investigating how autobiographical memory is retrieved, as well as the neural networks involved in associative processing when participants re-envisage/re-constitute an original memory, contributes to our understanding the neural components of ideasthetic imagining.

Neuroimaging research suggests there are core brain areas that drive episodic memory retrieval (past events of someone's life) and imagining future events (Beaty et al., 2018). These brain areas include the hippocampal and parahippocampal areas, medial temporal lobes, posterior cingulate/retro-splenial cortex, parietal lobule and posterior parietal cortices (Addis et al., 2008; Benoit & Schacter, 2015). Furthermore, these brain areas are associated with functional neural networks that govern autobiographical memory encoding and retrieval, imaging the future and self-reflection (Benoit & Schacter, 2015). Figure 1 illustrates where these areas are anatomically located by illustrating the main anatomical planes: A) the location of brain areas and other anatomy; B) the four main brain lobes of interest to the study; C) the brain regions of interest to the study.

The activity in brain areas associated with retrieving and recalling autobiographical memories varies according to the personal significance of the memory. For example, using functional magnetic resonance imaging (fMRI), D'Argembeau et al. (2014) used cues to trigger 24 participants to recall five personally significant autobiographical memories and generate five less-significant memories. D'Argembeau et al. found the frontal areas of the brain were more active when participants reflected on the personal significance of the recalled memory, while the limbic, frontal and posterior regions of the brain were all activated when participants focused on the specific factual content of a memory with the aim of re-experiencing those memories in their original context (D'Argembeau et al., 2014). These results suggest additional and distinct brain areas are involved if the memory has personal significance and that these brain areas are salient to the construction of past episodic memory.

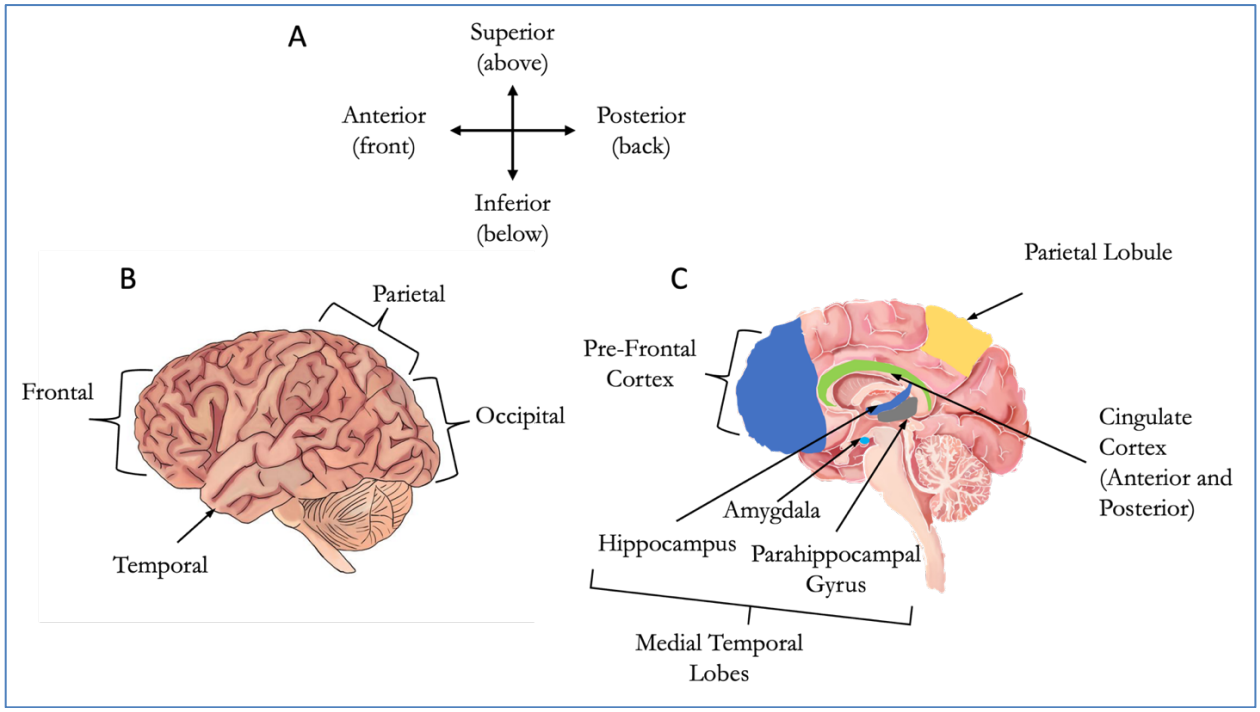

Figure 1 Anatomical. Planes and Brain Regions of Interest Based on Schacter et al., (2013). Note: A) Anatomical planes used to define locations of anatomy, include areas of the brain; B) The four main lobes of the human brain and regions of interest for this study; C) Brain regions of interest for this study.

A 2013 study used fMRI to investigate neural activity during a creative writing generation task (Shah et al., 2013). The authors claim that this study "can be regarded as the first contribution to scientific literature that applies an actual writing paradigm with a creative story generation task" (p. 1095). The sample comprised 28 participants who were instructed to read and then write a continuation of a given literary text. Participants completed a baseline task where they copied the beginning of the text before brainstorming ideas for their creative continuation, without being allowed to actually write. Finally, participants were instructed to "write a new, individual, original but appropriate continuation of the given text" (p. 1090). The study illustrates the activation of several regions of the brain during the various stages of the creative writing activities engaged in the study.

A 2014 study used fMRI to investigate the neural processes underpinning creative writing and literary education (Erhard et al., 2014). The task parameters of this study were identical to the 2013 study conducted by Shah et al., however this study comprised 48 participants and compared participants who identified as creative writing students (labelled 'expert writers') to a control group of participants with no writing experience. The study illustrates the activation of several regions of the brain during various stages of the creative writing activities and, pertinent to our hypotheses, notes discrepancies between brain activity in expert writers and inexperienced writers.

These findings were further extended by Neumann et al. in 2018. This study asked participants – a sample of 23 expert writers undertaking an average of 21 hours of writing a week and 28 non-expert writers undertaking up to 0.5 hours of writing a week – to complete tasks focusing

on the recall of associations (beginnings and ends of words; forming sentences from cues; inventing names) and the recall of ideas (alternative uses for words and phrases; new words and phrases). The expert writer participants demonstrated a larger creativity index, determined by scores from the recall tasks, compared to the non-expert writer participants. This finding was supported by MRI results indicating the volume of grey matter in the frontal (superior and middle frontal gyrus) and posterior areas of the brain were larger in participants from the group including expert writers compared to participants from the group of non-expert writers. Neuroimaging evidence therefore suggests that, compared to non-expert writers, expert writers have greater grey matter volume in the areas of the brain associated with planning and creativity (Neumann et al., 2018). The authors also found that increased grey matter volume in the right frontal area of the brain is linked to the time participants invested in writing practice. Expert writers utilise these areas of the brain more often and show an associated increase of grey matter volume in these regions (Neumann et al., 2018).

Overall, these collective findings suggest multiple consistent brain areas are active during autobiographical creative writing and during creative writing tasks that require thinking about the future. Notably, these areas include the frontal and parietal regions as well as the regions of the brain associated with memory, such as the hippocampus and amygdala (D'Argembeau et al., 2014; Neumann et al., 2018; Shah et al., 2013). Significantly, fMRI and MRI neuroimaging research reveals that interactions between brain areas associated with creative writing and autobiographical memory involve three large neural networks located in the frontal, parietal and memory areas of the brain and that these areas contribute to creative task performance involving autobiographical memories (Beaty et al., 2018). As previously mentioned, the scope of the current article is restricted to contrast analysis in target regions of the brain, with data analysis of neural networks ongoing.

Linking extant literature to the exploratory study

As established, the exploratory study herein aims to address the limitations identified in associated extant literature through variations in protocols, the levels of participant creative writing expertise and the neuroimaging modalities employed in data collection.

Participants in extant studies were guided to write creatively from existing texts (for example, newspapers, poems) in various ways (for example, brainstorming ideas or writing in response to, or as a continuation of, a prescribed text). Participants were asked to generate responses to words (Beaty et al., 2018), poems (Liu et al., 2015), or in response to existing texts (Erhard et al., 2014; Shah et al., 2013). Notably, Ellamil et al. (2012) incorporated both drawing and writing requirements into the same creative acts, making it difficult to delineate whether the recorded brain activity was associated with drawing or writing creatively.

Participants involved in these target studies had varying levels of experience in creative writing, ranging from no creative writing experience (Beaty et al., 2018 Liu et al., 2015; Shah et al., 2013); novice practitioners (Liu et al., 2015); at least one year of practice (Liu et al., 2015); an average of 11.7 years of practice (Erhard at al., 2014; Neumann et al., 2018); to an average of 21 hours of practice per week (Lotze et al., 2014). To our knowledge, fMRI and MRI are the

only neuroimaging tools that have been used to measure changes in brain activity in response to a creative writing task to date (Beaty et al., 2018; Shah et al., 2013), or to compare brain activity between non-writers and participants with writing experience (Erhard at al., 2014; Liu et al., 2015; Neumann et al., 2018).

Overall, this evidence highlights significant heterogeneity in creative writing and neuroimaging research, which limits the generalisability of differences in brain areas associated with autobiographical creative writing. The exploratory study addresses these limitations and extends current knowledge of how the brain perceives, interprets and produces creative writing responses with autobiographical memory as the primary stimuli. Furthermore, the exploratory study includes a group of expert creative writers selected through specific inclusion criteria; has a definitive focus on personally significant unresolved autobiographical memories; and uses MEG, a neuroimaging tool that allows the research team to track brain activity in real-time, with high temporal and spatial resolution and time-stamped against clearly delineated creative writing tasks.

While the exploratory study was always intended to include practising (mid-career) writers with developed knowledge and skills relating to creative writing techniques, the value of a study including both writers and non-writers is evidenced by the limitations of the flagship study, as noted by Shah et al in 2013. The inclusion of non-writers provides scope for general comparative analysis and, more specifically, the opportunity for hypothesising about the extent to which ideasthetic imagining is a practice that can be learned and in which writers might become increasingly proficient. To our knowledge, there is no neuroscientific evidence utilising MEG to measure neural activity during both autobiographical reminiscence and creative writing practices, with a sample of mid-career and professional writers.

Significance of the explorative study

As outlined above, the exploratory study is novel in that it requires authors to employ autobiographical memory (rather than an existing literary text) as the primary stimulus for creative writing. Participants are asked to document an unresolved autobiographical memory as it was experienced, in-scene/in time, and then to write creatively from this memory of significant personal relevance: first re-envisaging the original scene from an alternative perspective and then re-imagining the original scene through imagined fictional scenarios. The researchers then analyse MEG data from both groups, comparing and contrasting the brain activity recorded while these tasks are first completed using long-term memory (Stage One) and then repeated using short-term memory (Stage Two).

In ethical review of the proposed exploratory study (undertaken for SUHREC) Nikolić (2021) refers to the subdivision of creative processes in the project design:

> The study proposed […] is very interesting. Creativity is probably the most important feature of biological minds and Julia Prendergast, with her colleagues, is set to investigate the dynamics of the brain during the creative process. She has a great method to induce creativity and has the proper subjects – creative professionals. Her

> method can break the creative process down into stages, [and] for each of these stages separately recording the brain activity. The choice of MEG is a good idea. MEG provides accurate information of the timing of brain activity, allowing for investigation of various types of oscillations in the signals. MEG can also be localized much better than EEG. This will allow the authors to approximately identify the brain regions involved in whichever effects they detect. (Nikolić, 2021)

The design of the ideasthetic imagining study and, in particular, the subdivision of creative processes, attends directly to Shah et al.'s (2013) recommendation for future studies, where "for a more precise investigation of the topic, the process of creative writing might be further subdivided and focused on single subprocesses" (p. 1100). This recommendation informs the design of the exploratory study, which is strategically formulated to capture the relationship between stimulus-for and stimulus-in by mapping brain activity at primary (reflexive) moments of narrative composition when working from unresolved, personally significant autobiographical memories.

In summary, the primary objective of the exploratory study is to monitor the dynamics of brain activity and investigate marked discrepancies between the experimental group (practising writers) and the control group (non-writers). The study design clearly delineates two disparate stages, distinguishing between brain activity during creative tasks derived from long- and short-term autobiographical memories. The research team centralise target regions of interest while also monitoring connectivity between neural networks more broadly (distinct article, forthcoming). This research provides us with opportunities to leverage MEG technologies to characterise the dynamic pattern of electromagnetic activity in the living brain while it is engaged in processes of ideasthetic imagining – showing where and when the brain's activity is concentrated while engaging with provocative, unresolved memories during acts of narrative creation. In this way, the study affords the research team opportunities for mapping the functional force of the unthought known in affect-driven writing.

During peer review for SUHREC, Jen Webb, notes:

> The embodied nature of autobiographical writing, and the recall of memory necessary to perform such writing, is not well understood, and this project is likely to illuminate it, as well as enriching knowledge and understanding of cognition in both healthy and injured brains, and for neurodiverse individuals. The project design allows the creative practice disciplines to move beyond speculation about creative thinking and into evidence of the processes of practice; it also allows neuroscientists to build understandings of the creativity that is part of human cognitive function, and allows pathways to impact by understanding how to enhance creative activity. (Webb, 2021)

Webb further notes that the potential significance of the exploratory study is in its focus on storytelling as it relates to personally relevant material:

> This is extremely exciting work […] likely to add considerable value to the research being conducted elsewhere in Australia, and internationally, into the affordances of creative practice for brain function and plasticity, and to help develop in individuals and communities the capacity to recover from traumatic experiences, and build

> resilience and future-mindedness. While there has been a body of research into this topic, using brain imaging to map the effects on damaged brains of music or visual art, less has been undertaken into the more internalised and mute practice of creative writing. This project adds something new to the field, in focusing on creative writing, and attending to the phenomenological experiences of imaging/imagining rather than physical immersion in an environment. (Webb, 2021)

Importantly, the research identifies and fosters creative writing as a tool for facilitating a connection with the past. Understanding cognitive processes that occur in various regions of the brain during the creative writing workshop contributes objective evidence on how we might potentially utilise creative writing practices to foster emotional intelligence and to facilitate a connection with the past that is focused on future-mindedness.

It is acknowledged that the primary limitation of this study is the small sample size of ten participants, comprising five writers and five non-writers, all of whom identify as female. A comprehensive outline of limitations, as well as possibilities for future research, is beyond the scope of this article, but available in a forthcoming article focusing on the connectivity between neural networks [5].

Preliminary findings: Creative writing processes and practice

Prior to discussing the preliminary findings of this research study, we momentarily deviate to reflect upon the established relationship between memory and creative play, as it is articulated more fully in 'Ideasthetic Imagining: Writing as Dream-membering' (Prendergast, 2022a). While we refrain from unnecessary elaboration, we note Prendergast's deep interest in psychiatrist Veronica O'Keane's (2021) rendering of emotion as the "sixth sense" (p. 66). In engaging with O'Keane's analysis of emotion as it relates to the conjuring of memory, and from the context of her own understanding of emotion and memory as they relate to acts of narrative making, Prendergast notes:

> O'Keane […] draws attention to Tulving's influential work, which focuses "how the past and future exist in the consciously experienced present" (O'Keane, 2021, p. 111). O'Keane notes that Professor of Psychology, Daniel Schacter, who worked with Tulving and built upon Tulving's work, "made big inroads into understanding the experience of time in his neuroimaging experiments. He showed that the same brain circuits are employed when thinking about the past and when planning for the future" (p. 111). (Prendergast, 2022b, p. 14)

Having previously examined the merging of past feeling with present feeling and thinking, and considering how past stimulus may be re-ignited in ideasthetic acts of narrative making, Prendergast notes that:

> the "intersection" between temporal states in acts of ideasthetic imagining is consistent with Freud's (2013) speculation in 'Creative Writers and Day-dreaming' and, in particular, his suggestion that the "[mental] work [of day-dreaming] is linked to some current impression, some provoking occasion in the present .... From there it harks back to a memory of an earlier experience" (p. 7). Once again, we are in the realm of the unthought known: "where nothing [emphasis added] is past or forgotten", where past

> feeling informs present feeling and thinking (Freud, 2010, p. 576). (Prendergast, 2022a, p. 9)

The research of Tulving, Schacter and O'Keane – in particular, the intersection between temporal states (past, present and future) in the activities of dreaming and remembering, together with the triggering of unthought known memories through active engagement with unresolved memories and experiences – is integral to the structure of the creative writing workshop underpinning the research study. In *A Collection of Moments: A Study of Involuntary Memories* (1970), Esther Salaman provides a rigorous account of our engagement with these triggers. Salaman – writer, translator, literary critic, physicist and psychologist – suggests that:

> There is another kind of memory of experience, which comes unexpectedly, suddenly, *so that a "then" becomes a "now"* [emphasis added]. Proust was not the first to describe such memories. Some have called such memories spontaneous, others revived; they have also been called unconscious or involuntary. Of all these names, none of which is perfect, I choose involuntary. (Salaman, 1970, p. 11)

Documenting her experience in writing the book, Salaman observes: "one memory brought back another as if a chain reaction had set in" (p. 21), further noting that "the recovery of memories does not result in our altering our pattern, but in recognising it" (p. 105). The creative writing workshop aims to facilitate a chain reaction, as well as a process of recognition, triggered by participants' engagement with (and reconstruction of) an original experience.

Preliminary data analysis undertaken for this study identifies theoretical links between the objectives of our study and the objectives of Schacter's work, particularly the article 'Constructive Episodic Simulation of the Future and the Past: Distinct Subsystems of a Core Brain Network Mediate Imagining and Remembering' (Addis and Schacter et al., 2008), in which the authors examine relationships between brain activity when remembering events and brain activity when imagining future events. The authors report:

Compared with the considerable attention devoted to understanding how episodic memory enables remembering of past events, and the heated debate over mental time travel in nonhumans, there has been far less work exploring how people use episodic memory to imagine future events. (Addis and Schacter et al., 2008, p. 2022)

Importantly, their results reveal that:

> A major message of this emerging body of research is that remembering past events and imagining future events depend, to a very large extent, on shared cognitive and neural processes […, and] investigations of various patient and subject populations indicat[es] that *deficits in episodic remembering are associated with similar deficits in imagining future or novel events* [emphasis added]. (Addis and Schacter et al., 2008, p. 2022)

The relationship between deficits in episodic remembering and the ability to imagine future events is a primary area of interest for the research team. The creative writing workshop that

underpins this exploratory study is strategically designed to contrast deficits and capabilities in remembering and imagining. Given the sheer size of data potentially sourced from the brain, establishing domains was necessary for more efficient analysis. Schacter et al. (2009) identifies a core brain network engaged during remembering and imagining – the hippocampus, posterior cingulate/retro-splenial cortex, inferior parietal lobule and medial prefrontal and lateral temporal cortices (see Figure 1) – which informed the creation of domains implemented in the preliminary contrast analysis of this study.

This preliminary analysis identified marked differences in the recorded brain activity of writers and non-writers. These differences were most apparent during Stage One: Exercise 2, when participants were asked to write about a long-term, personally significant memory from a perspective other than their own (see Figures 2 & 3). Contextualised against established conceptual understandings of how memory recall and creative imagining occurs, the most notable finding in our preliminary contrast analysis is the marked discrepancy in brain regions and neural networks that are engaged by writers and non-writers re-imagining long-term memory from an alternative perspective.

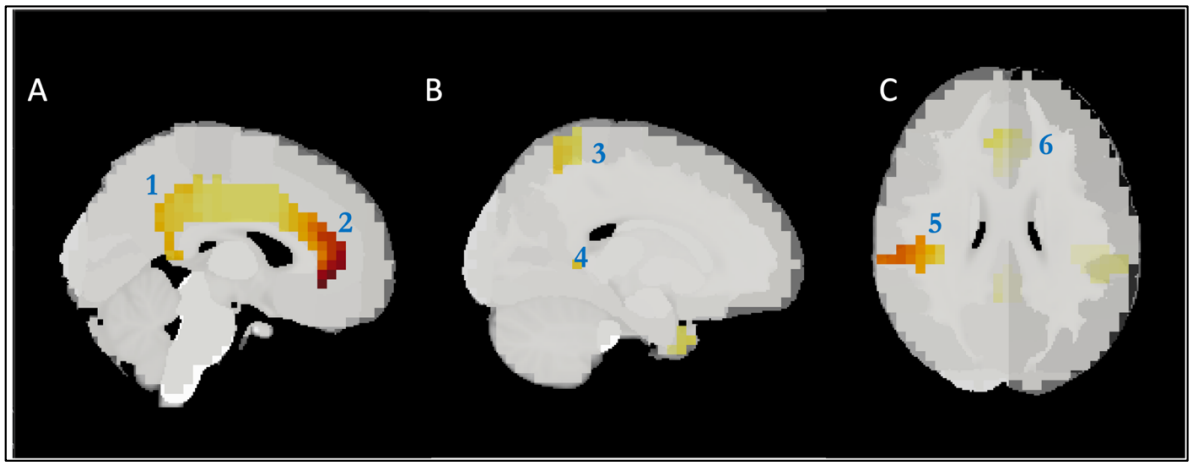

Figure 2. Contrast between writers and controls in Stage 1: Exercise 1 and Stage 1: Exercise 2 for the delta band. Note: a) Presents significant differences of grid points (5mm) on the sagittal plane between the writers and controls in the left posterior cingulate ([1]100%), right posterior cingulate ([1]50.4%) left anterior cingulate ([2]51.0%), right anterior cingulate ([2]42.7%); b) Presents significant differences of grid points (5mm) in the coronal plane between the writers and controls in the left posterior left superior parietal lobule ([3]23.8%), left posterior cingulate ([4]100%), right posterior cingulate ([4]50.4%); c) Presents significant differences of grid points (5mm) in the transverse plane between the writers and controls in the left temporal occipital fusiform cortex ([5]11.3%), left anterior cingulate ([6]51.0%), right anterior cingulate ([6]42.7%).

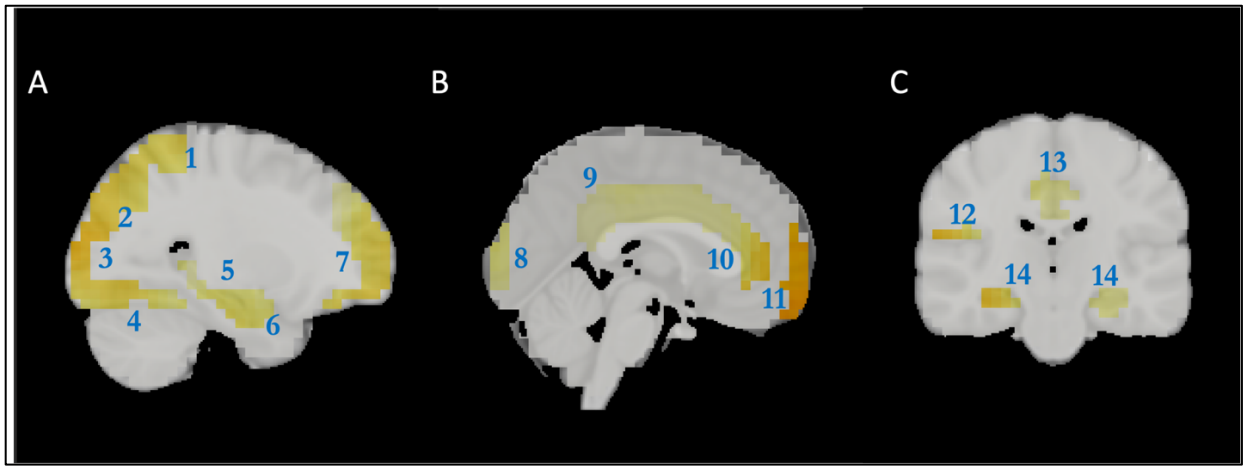

Figure 3. Contrast between writers and controls in Stage 1: Exercise 1 and Stage 1: Exercise 2 for the theta band. Note: a) Presents significant differences of grid points (5mm) on the sagittal plane between the writers and controls in the left superior parietal lobule ([1]97.6%), left lateral occipital cortex, inferior division ([2]100%), left lateral occipital cortex, superior division ([2]98.3%), left occipital fusiform cortex ([3]100%), left temporal occipital fusiform cortex ([4]100%), left hippocampus ([5]35.7%), right amygdala ([6](3.8%), right frontal pole ([7]1.4%); b) Presents significant differences of grid points (5mm) in the coronal plane between the writers and controls in the 96.3% left occipital pole ([8]96.3), left posterior cingulate gyrus ([9]80.7%), right posterior cingulate gyrus ([9]56.4%), left anterior cingulate gyrus ([10]35.7%), right anterior cingulate gyrus ([10]42.7%), right frontal pole ([11]1.4%) right hippocampus (3.5%); c) Presents significant differences of grid points (5mm) in the transverse plane between the writers and controls in the left posterior operculum cortex ([12]100%), right and left posterior cingulate gyrus ([13]and the right amygdala ([14](3.8%).

In response to this finding, the researchers focus on capabilities. We take a deep interest in the way sustained practice, in the experimental group of practising writers, appears to be reflected in an aptitude for imagining a long-term memory from an alternate perspective. The experiences of the experimental group of practising writers are outlined in a co-authored TEXT essay, 'Fringe Dwelling in Autobiographical Memory – Writers' Perspectives' (Prendergast, Hecq, Michael, Munoz, van Loon & Webb). In this essay, the experimental group reflect upon the creative writing workshop, particularly their experience of writing a long-term memory – as they experienced it at the time and, subsequently, from a perspective other than their own.

Collectively, the authors ruminate upon the operations-of-practice that underpin the act of writing creatively during the workshop. In particular, they interrogate their experience of actively imagining lived experience through another person's 'skin'. This activity corresponds with the most marked finding in preliminary contrast analysis: writers have developed an aptitude for empathic engagement with lived experience via a perspective other than their own. Writing a memory via another register involves imagining a future that includes a re-envisaged past – a reconstruction of original experience (then as now), which calls for the temporal flips and turns of mind at the heart of theories of memory – as focused in Tulving, Schacter, O'Keane and Salaman's research.

Conclusion: Opportunities for future research

Through the collection and analysis of brain activity during the practice of creative writing, the explorative study investigates the potential for creative writing processes to foster connections

between the author and their past by conceptualising remembering as an act of imagining, and by facilitating opportunities for creative invention. Understanding which, as well as how, cognitive processes occur in various regions of the brain during creative writing practice contributes objective evidence of how these processes might assist individuals in experiencing emotional wellbeing and future-mindedness. Through combining an examination of the brain's microstates during precisely defined subprocesses of ideasthetic imagining with pre-established theories of how memory functions, this study affords us opportunities for considering the ways our findings may be applied beyond creative practice, such as to the implementation of creative writing workshops in health|wellbeing and education settings.

By applying neuroimaging techniques to investigate the neural changes associated with creative writing – in particular, unresolved or incomplete autobiographical memory – our primary research provides fundamental insights into the neural basis of creative cognition in this context. This leads us to the most staggering finding in initial data analysis, illustrating that sustained creative practice among the experimental group (practising writers) is reflected in heightened activity in target regions of the brain – particularly in Stage One: Exercise 2, where participants are working from long-term autobiographical memory, and re-envisioning the scene from an alternate point of view.

In response to the findings of this novel research, the research team considers increased understanding of cognitive function – as it relates both to creative writing processes and practice, and to future-mindedness – as a key research outcome. Evidence from systematic reviews suggests reminiscence therapy and creative writing practice not only improve symptoms of depression and anxiety, but also effectively help people recover from these afflictions (Chiang et al., 2019; Liu et al., 2021; Mundy et al., 2022). The neural mechanisms of how reminiscence therapy and creative writing practices improve symptoms of depression and anxiety are unknown but the research team hypothesises this may involve changing cognitive patterns and activating neural networks. Understanding the cognitive and neural processes that occur in the brain during reminiscence-focused creative writing will thus contribute objective evidence of how symptoms of depression and anxiety are potentially ameliorated through methods other than pharmaceutical. Given significantly poor health statistics on the global impact of depression and its sequelae (Luppa et al., 2012), reducing the economic (Haller et al., 2014, p. 10; König et al., 2020, p. 13) and personal (Livingston et al., 2020: 424) impacts of poor mental wellbeing is a significant societal issue.

Certainly, functional neuroimaging evidence suggests the default mode network increases activation during recall of autobiographical memories (Cîrneci et al., 2022), and creative writing involves the lingual gyrus, the fusiform gyrus and the parahippocampal gyrus (Chen et al., 2020) – all areas impacted through the experience of depression, anxiety and dementia (Chen et al., 2021; Klaassens et al., 2017). To our knowledge, there is no functional neuroscientific evidence that measures neural activity during both autobiographical reminiscence and creative writing practices and, consequently, the objective evidence – gathered in this study and subject to further analysis – is designed to provide insight into the neural mechanisms of reminiscence-focused creative writing processes.

The overall aim of the exploratory study was to investigate neural activity involved in creative writing processes and practices, with the primary aim of contrasting activity between practising writers and non-writers when writing from unresolved autobiographical memory. Preliminary findings from the exploratory study encourage us to consider the benefits of sustained practice as a therapeutic tool for future-mindedness. On the basis of our analysis of preliminary data, we are considering how participants in target groups within the broader population may benefit from workshops including the processes and practices that underpin the workshop.

The creative writing workshop at the heart of the exploratory study facilitates pathways to future-mindedness – a core component of emotional wellbeing. The workshop has the potential for adaptation and development in a variety of contexts. Applications may include customised workshops for people with anxiety and depression, with the potential for further therapeutic applications in conditions where imaginative and empathic pathways are (temporarily or fundamentally) blocked or impaired. The research team take a particular interest in prospective thinking as an antidote to the debilitating nature of excessive, unproductive rumination – often a severe symptom for people with depression and anxiety. This novel research provides preliminary objective evidence, contributing further insight into the neural mechanisms of how reminiscence-focused creative writing practices might provide a useful basis for thinking strategically about future-mindedness and wellbeing.

Opportunities for further research include an expanded study, increasing the scale of data while maintaining a focus on contrast analysis in target regions of the brain, and on connectivity between neural networks, as identified in the preliminary exploratory study. As we progress with ongoing data analysis, we remain inspired by the scope for utilising the methodological approach of the workshop – modifying the workshop for target groups with the aim of improving future-mindedness and wellbeing, as well as the possibility of reducing the demand for associated health and social care. With these future applications in mind, we intend to maximise the impact of our research findings by applying for nationally competitive grants and large-scale industry partnerships, thereby facilitating further research with an expanded scope.

Notes

[1] Prendergast unpacks the way she way she employs the term realism through a conception of narrative realism, which is not necessarily consistent with the history and tradition of realism in the literary canon, in the following essay: Prendergast, J. (2024). Writing the mire – ‘for we are loom.’

[2] Prendergast outlines her conception of the activities-of-mind that underpin narrative lyricism in further detail in the following essay: Prendergast, J. (2025): Realism, granite, rainbow – life, memory, art.

[3] Prendergast has previously drawn a correlation between ideasthetic acts of narrative making and the psychoanalytic relationship:

> Theorising about the twin processes of stimulus-for and stimulus-in, as paired activities of meta-cognition, draws me to Christopher Bollas's concept of the unthought known (2014, p. 19). The theory of the unthought known refers to the primary repressed unconscious as a repository of experiential knowledge. Bollas postulates the concept of "the immaterial intelligence of form" whereby "the analyst (like the artist) breaks the figure; not to find out what is inside but to realise the immaterial intelligence of form" (Bollas, 2014, p. 19). The author's iterative understanding of the evolving text is also an engagement with the immaterial intelligence of form – a "reconstruction" of the author's unthought known in the form of concrete and specific narrative detail. In this way, the author's engagement with the text, in ideasthetic acts of narrative making, mimics the psychoanalytic relationship. (Prendergast 2021, p. 5)

For a more comprehensive discussion please see Prendergast (2021), Prendergast (2022a). and Prendergast (2022b).

[4] Extract from the Debriefing statement:

> Your participation in this study required you to attend one testing session at Swinburne University of Technology, Hawthorn, where you (i) completed some questionnaires and assessments, followed by (ii) a MEG scan while you participated in a creative writing task and (iii) a MRI structural scan. This is because we are interested in understanding where and how the brain recruits various processes during focused imagination and creative writing.
>
> Importantly, there are no right or wrong answers associated with any of the questionnaires, assessments, or the creative writing task you have completed today.
>
> The recording of your brain activity using MEG, and structural scan of your brain using MRI, are both considered very safe procedures when the proper safety controls are adhered to, as they have been in this study.
>
> When all of the data has been collected and analysed, the results from this research will be reported in publications and/or at conferences. No information will be presented that identifies you personally without your permission. The principal researcher, Dr. Julia Prendergast, will be pleased to tell you more about the research, or answer any questions you may have – please see her contact details at the bottom of this document.
>
> If you have experienced any discomfort, anxiety or distress during the study, or if you are concerned about your mental state in any way, please inform the principal researcher who will be able to provide you with the appropriate support. Please also refer to your copy of the Participant Information and Consent Form which lists some relevant support services.

[5] A comprehensive outline of limitations, as well as possibilities for future research, is outlined in a forthcoming article focusing on the connectivity between neural networks: Prendergast J, Slade B, Lyons P, 2025, 'Curiosity in Creative Writing through the Lens of Neuroscience' (commissioned by Graeme Harper for a collection: *Creative Writing Curiosity:*

Ten Essays on the Curious and the Writerly, Texas Review Press, a university publisher at Sam Houston University in the USA).

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