

Diffracting Artistic Intervention: A Transdisciplinary Approach to Understanding
Creative Process in Art Education

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ABSTRACT

Diffracting Artistic Intervention: A Transdisciplinary Approach to Understanding Creative Process in Art Education

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Pedagogical possibilities for teaching and learning are uncovered through a propositional approach to inquiry that entangles recent findings in the neuroscience of creativity research with arts-based theory and practice. The transdisciplinary potential for creative dispositions to inform education and mobilize knowledge in new ways makes emergent findings regarding creativity-priming important for art educators. This research diffractively investigates the artistic experience of two arts-related groups engaging in creative activities, particularly those involving the planning, design, and artistic communication of ideas, to examine metacognition of the interoceptive (mindfulness) and exteroceptive (priming) influences asserted in the neuroscience of creativity. Assemblages of data are diffracted and read-through one another to illuminate congruences in the lived experience and creative processes of student artists, art educators, and artist-scientists, leading to transdisciplinary pedagogies and ecologies of practice.

Keywords: art education; neuroscience of creativity; creative process; diffraction; entanglement; proposition; posthuman; pedagogy; difference.

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DEDICATION

For the ones who say 'yes' to magic.

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Glossary of Terms

Terminology Related to the Posthuman Turn

Alignment. The metacognitive awareness of an environment and one's place within it. This concept relates to the positionality and performativity of a researcher or artists within an assemblage (see Gallagher, 2015).

Attunement. Relates to metacognitive dispositions that enable a researcher or artist to respond meaningfully in relation to the environment (see Gallagher, 2015).

Deleuze and Guattari. French philosophers who hold that knowledge operates between structures of "certainty" (a reference point of assumed understanding) and rhizomatic "lines of flight" (thoughts which follow intuitive, non-linear pathways). This approach is contrasted with a more linear, scientific method found within logical positivism.

Désire. The intuitive motivation to create or explore. When *désire* meets the plane of immanence via a line of flight, there is the possibility of generating a new "aha" moment wherein ambiguity coalesces into "meaning." In posthuman theory, Massumi (2015) describes this as *supranormal*, citing behaviour in animals who improvise when a novel situation is presented. The creative impulse in humans is aligned with this supranormal behaviour.

Diffraction and reading diffractively. As understood in the context of contemporary feminist theory and art education theory, diffraction refers to Barad's (2007) expression of relationality, akin to the quantum physics of individual waves overlapping, and the disruptive phenomenon that occurs when they encounter an obstacle, causing new patterns of interference as they fall

back onto one another in new formations. Noticing “patterns of difference that make a difference” (Barad, 2007, p. 72) challenges assumed perspectives, as with a researcher pursuing an inquiry. While reflection can document difference, diffraction on the other hand is a process of *producing* difference. “A diffractive methodology...is not setting up one approach /text/ discipline against another but rather a detailed, attentive and careful reading the ideas of one through another, leading to more generative ‘inventive provocations’” (Bozalek & Zembylas, 2017, p. 115). Barad (2007) proposed reading ‘through’ different texts and theories instead of reading hierarchically.

Encounter. In terms of art education, a concept meaning an event wherein an artist experiences a departure from preferred forms, content, or approaches. I adapt the meaning from Deleuze and Parnet (2007), who describe a novel inquiry that disrupts a familiar process, achieving a more authentic creativity.

Intra-action. A key concept of agential realism (Barad, 2007). An agency is only distinct in terms of its entanglement or in emergent relations to other agencies. This approach focuses on the performativity of an entity rather than an object within an epistemological subject-object binary.

Line of flight. An intuitive departure from concrete knowledge, according to Deleuze and Guattari (1987). I adapt flight to mean movement rather than to ‘fly’ or flee from. In terms of art education, a line of flight can be the product of curiosity stemming from an *encounter*.

Nomadic. Refers to Deleuze and Guattari’s concept of cognition as non-linear. This concept, along with Haraway’s (2016) *tentacular thinking*, suggests that thought combines more than an isolated logic and is connected to memory and feeling.

Nonhuman, More-than-human. Most notably refers to the relationships between human and nonhuman entities as well as art, science, and technology. The ‘more-than-human’ is an affirming reframing of the ‘nonhuman’ movement, itself a redefining of humanity’s place in the world that resists anthropocentrism, the centrist notion of humans as the dominant life form (Grusin, 2015).

Plane of immanence. The unrealized agency of phenomena that becomes realized through interaction with an inquiry (via a line of flight) (Deleuze & Guattari, 1987), related to pre-cognition/pre-conscious “knowing.” It is an anticipatory state of ambiguity, sensing the potential for a provocative connection to be made, generating resonant ideation.

Posthuman turn. A response to (or extension of) phenomenology, which asserts that a material entity or process is predicated upon our perception of it. By contrast, a posthuman framework asserts that entities, materials, and phenomena are the product of their performance within an assemblage (see Hood and Kraehe, 2017). Therefore, the agency of all components in addition to the physical presence and perception of the researcher are co-constitutive of an assemblage.

Rhizome. A rhizome is a bottom-up (undirected) cognitive process of sense-making drawing upon memory, curiosity, and insight (Deleuze & Guattari, 1987)—a non-linear inquiry akin to directed wandering (*dérive*) in the neuroscientific study of creativity (Goldberg, 2018) or *tentacular thinking* by Haraway (2016).

Tentacular thinking. A term used by Donna Haraway (2016) to describe a complex network of ideas combined and juxtaposed together that can add robustness and dimension to an investigation.

Terminology Related to Neuroscience of Creativity

Creativity. The standard definition for creativity is that it “requires both originality and effectiveness” (Runco & Jaeger, 2012, p. 92). “Originality” is often replaced by “novelty,” and “effectiveness” is interchangeably “usefulness” or “purposefulness.” “Surprise” can be a third criterion (see Simonton, 2012, 2018a, 2018b).

Creative Play. Aligned with counterfactual thinking, the role of imagination in play juxtaposes *what happens if?* with *what could have happened differently?* Play within an inquiry has fewer constraints as there is no anticipated outcome, nor is the activity attached to a particular problem. It is investigative and exploratory in nature, building familiarity with the domain, testing the possibility of materiality and technique that are vehicles of an inquiry.

Counterfactual Thinking. A process involving exploring possible changes to effects if the causal circumstances are altered. It challenges the mind to invert perceptions of a situation, which may reveal fresh insight into a problem or inquiry. For example, an artist struggling with a project could imagine the impact of changing emphasis, medium, or material.

Delaying Closure. Intentionally persisting in ambiguity within a creative inquiry to allow for novel insights to emerge.

Divergent/Convergent Thinking. A cognitive process that generates multiple connections or solutions to a concept or problem. Convergent thinking involves aligning ideas generated in divergent thinking with the parameters of an inquiry to select the most salient or viable one(s).

Exteroception. External influences that are perceived within a creative inquiry. They include but are not limited to environment, audience, context, materials, time, and space.

Fluency. The ability to generate a significant number of relevant options.

Flexibility. The ability to generate a diverse range of relevant options.

Interoception. The internal influences active during a creative inquiry. They include but are not limited to memory, curiosity, intrinsic motivation, affect, and cultural background.

Metaphor (aesthetic). Another form of representation where a concept/narrative/image symbolizes another, as the symbolization may incorporate imaginary or impossible elements. Devising a metaphor requires making a recognizable, relevant association to a concept.

Mind Wandering. Cognition during which deliberate and automatic constraints are mostly relaxed and thoughts wander from topic to topic, flowing with ease over time. Creative thoughts are characterized by their hybrid nature, including phases of relatively flexible thinking (brainstorming) as well as phases of more deliberately constrained thinking (when evaluating or fine-tuning ideas).

Neural Networks. A concept within the neuroscience of creativity which explains the simultaneous activation or suppression of different regions of the brain during creative work. These include the Default Mode Network (DMN) for generative and divergent thinking; the Salience Network (SN) filtering for criteria; and the Central Executive Network (CEN), which governs assessment and adjudication (convergent thinking).

Overcoming Knowledge Constraints. Constraints may be the lack of previous knowledge or defaulting to familiar subjects and methods. These can be altered through research, experimentation, or training. For an artist, it may include working with unfamiliar materials or techniques; for scientists, it may require partnerships with peers who have more specific knowledge regarding a research domain.

Priming. A strategy involving preparatory activities intended to activate connections between long-term memory and working memory. These can include warm-up exercises or research activities designed to inform content or context. *Task-related* priming involves preparatory activities related to an inquiry intended to promote more effective creativity. For example, within artmaking an artist may compile images that provide direct visual references for a creative task. However, it has been demonstrated that priming need not necessarily be task-related to be impactful (Minas & Dennis, 2019). *Non-task related* priming relates to preparatory activities unrelated to a specific inquiry. In some contexts, exposure to non-task related priming, including configuring the working environment (such as arranging a space, degree and type of light, temperature, sound, proximity to others), has been shown to correlate with improved performance on creative tasks (Minas & Dennis, 2019). *Supraliminal* priming occurs when the participant is aware of the priming material.

Rarity. The more remote the priming material from the creative endeavour, the greater the likelihood of achieving novelty, a key factor in generating creativity.

Scientific Method. According to the OED (3rd ed.), the scientific method is “a method of observation or procedure based on scientific ideas or methods; *specifically*, an empirical method that has underlain the development of natural science since the 17th century, comprising some or all of a) systematic observation, measurement, and experimentation, b) induction and the formulation of hypotheses, c) the making of deductions from hypotheses, d) the experimental testing of the deductions, and (if necessary) e) the modification of the hypotheses; though there are great differences in practice in the way the scientific method is employed in different disciplines.”

Persistence and Flexibility. Persistence is the ability to sustain a creative task regardless of the outcome, while flexibility is the capacity to be open to change during the course of the inquiry. The

initial phases of a task require more flexibility (*divergent thinking*), during which time the neural networks that govern persistence are diminished. Once a flow state has been established, the networks governing persistence are more active. Related to flexibility is the response to what an artist might describe as failure, or lack of resolution. These may include inconclusive results, flawed prototypes, or unsatisfactory drafts in writing. That said, the experience and learning gained in failure and persistence in the pursuit of ideas increases the probability for creative outcomes to occur, particularly when there is a metacognitive analysis of the failure. It is also relevant to note that those with higher creative output are often those with a greater number of failures, given their proclivity to experiment.

Table 1

Common Terms with Different Meaning and Different Terms with Common Meaning

Domain conceptual congruences	
Art Education Theory	Neuroscience of Creativity
ideation/selection	divergent/convergent thinking
affect/personal narrative	interoception
aesthetic literacy	exteroception
desire	curiosity
plane of immanence	priming/problem finding
nomadic/tentacular thinking	mind wandering/hypofrontality
encounter	insight/inspiration

Preface

Exploring how to ignite creativity may change the way we teach in the future. As an artist and art educator, I want to know what will increase the chance for inspiration to occur, both inside and outside the classroom.¹ This dissertation uses a posthumanist diffractive theoretical and methodological framework to re-examine dispositions and processes relevant to creativity, both in art education and transdisciplinary (transdomain) learning contexts. It is co-constituted, in that the agential materiality of thinking-writing, creating, teaching, and learning, whether in-person or online, involves intra-action. It is also informed from the diffraction of transdisciplinary research that attempts to reach across and through the boundaries of artistic and scientific practice to examine relational dispositions, materialities, potentialities and intra-actions.

Diffracted propositionally through posthumanist theory and emergent neuroscientific understandings of creativity, I interrogate the meaning and matter of artistic creativity. Taking up what philosopher Rosi Braidotti (2013) termed the *posthuman* and focusing on the potential for new insights unfolding and emerging from a diffractive process, my inquiry is a form of intra-relational sympoiesis: making-with as a shared call and response to *becoming-with* (Haraway, 2016) in art education through the creative process. In fluid, boundless, and interwoven movements of intra-action and reflection, I investigate how artistic metacognitive processes and the affect-effect of making are implicit, relational, situated, transversal, and potentially transferable within pedagogies

¹ Retrieved from my 2021–22 Public Scholar Profile

<https://www.concordia.ca/sgs/public-scholars/alumni/2021/trish-osler/trish-osler-my-inspiration.html>

of practice (see Klausen, 2014). I am guided by the prospect that creative ideas may be sparked by new knowledge of how to access *matter* and that ideation can be primed through artistic pedagogical interventions, particularly when memory and curiosity combine, shifting immanence to ideation.

Figure 1

Determining the Plane of Immanence for this Research Inquiry

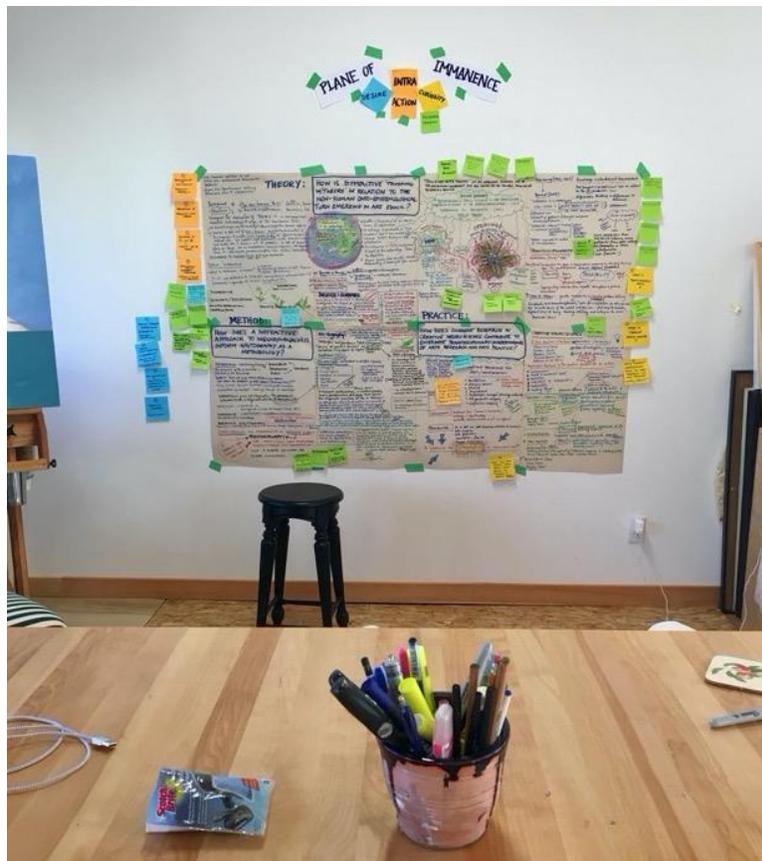


Photo Credit: T. Osler

Before coming to graduate studies in art education, I taught visual arts at the secondary level and kept a studio. My career has spanned the breadth of creative enterprise, first in the commercial sector and later evolving to personal practice. An early start in the advertising

industry provided insight into multimodal relationships among aesthetics, memory, perception, and desire and provoked in me a deep curiosity about the power of creativity to influence meaning-making, both individually and in socio-cultural ways. During this time, the impact of visual culture on aesthetic literacies was rising in line with a corresponding uptake in social and digital media. Access to new technologies placed opportunities for creative expression within the purview of all consumers, not just professionals who practiced or studied art. Through a diffractive design process, utilitarian devices (like phones) morphed with new technologies to become artistic tools or *other than* (phones), liberating artists and non-artists alike from the strictures of aestheticism.

As understandings of creativity and creative practice changed, my career changed too, moving further along the spectrum of artistic endeavour: from commercial production to conservation to curation; from art-thinking to art-writing to art practice and ultimately, to teaching. Setting aside my studio work as an artist and restorer, I became an art educator, and thereafter for nearly two decades I have operated within the alchemic creative exchange of an art room. While teaching K–12 Visual Arts throughout the early 2000’s, I concentrated much of my time on understanding best practices in a creative context. This led to querying stakeholder interpretations of what creative practice is and means in art education. Exhilarating discoveries made by students learning about their own capabilities and artistic thinking processes impressed on me the shared affect that is central to the experience of collaboration, experimentation, and creativity. My students’ journeys in the art room closely resembled those of my own lived experience as an artist, kindling an embodied awareness and a way of knowing and being in the world that flourished through artmaking.

During classwork, I could not help but notice the intensity of focus and effort students applied to the resolution of an artistic problem or challenge. While this was evident across all stages of learning at the school where I taught, it was later—working with senior level students in an independent girls’ school and focusing on curricular scope and sequence—that I found myself drawn further into questions around creative process and pedagogies, ecologies of practice, mindfulness, artful exchange, and cross-disciplinary connections. Through various encounters, reflections, student journals, and my own informal classroom observation, I noticed that students often described the creative conceptualization process as something immanent: sensed, but not yet formed.

In practice, I had discovered that once a creative process was underway, with contextual research harboured in students’ image files and sketchbooks, little in the way of teacher intervention could provoke a more satisfying outcome than the one the student had already conceived or intuited. Sometimes the student artist did not know how to explain it or define what *it* would come to be. However, their expressions of uncertainty and feelings of vagueness about the process by which a concept or idea would eventually emerge did not seem to concern them. Artists at every level are familiar with ambiguity. With artmaking, there appears to be at once the desire for an outcome that reflects a personal expression, and at the same time a tolerance for an as-yet-unknown outcome.

My students often revealed that their preconceptions of an artistic outcome at the beginning of a creative task remained fluid (Thomas, 2019), even veiled, waiting to be discovered through the process of experimentation and making. They seemed comfortable with the notion that creative conception can be imperceptible yet felt, needing only to be winkled out from an entanglement of conscious and pre-conscious thought/experience. This entanglement,

intrinsically interlaced and entwined with materiality, forms the essence of what I believe artists contend with when engaging in artistic activity. I could see that some of my students were encouraged enough by the familiarity of *not* knowing to bring dispositional thinking, such as perseverance and resilience, to the messy process of creative experimentation.

In my own role as an artist, I regularly engage in such studio dispositions—habits of mind characterized by Hetland et al. (2007). In my role as art teacher at the secondary level, I encountered these same artistic thinking processes in students as they grappled with the challenges of instrumentalist approaches to school art production, experimenting with an array of media, materials, and techniques in the art room. Like many artists and art educators who maintain artistic practices, I savour the ineffable process of creation. I recognize also that it is hard work: that period of foment and percolation during which the artist ruminates, ponders, forms and re-forms a concept before it emerges, as if of its own accord, into being. This is not to suggest that the process of experimentation, observation, and reflection is singularly artistic, but that it is in fact a shared method of inquiry with values and habits of mind common to many disciplines—certainly to learning in general, though perhaps less concretely practiced outside the art room or the science lab. And so it was owing to the combination of my personal artistic experiences and illuminating encounters in classroom teaching that provoked in me a specific curiosity around theoretical context, the desire for deep thinking about what it is to teach art and to inspire creativity, and how it is to learn alongside the students we guide and encourage.

Part way through doctoral studies, I was offered the opportunity to instruct pre-service teachers in community art education through the department of Art Education. At the postsecondary level, I saw attributes and dispositions similar to those I had encountered in younger students and intuitively practise myself as an artist and art educator. These courses provided informative

exchanges with students that situated teaching and learning about creativity at the centre of my research practice, later providing rich sites for data collection.²

To better appreciate ecologies of practice, emergent pedagogies, and the neuroscience of creativity (NsC), I also joined the Montreal-based organization known as the Convergence Initiative (<https://www.convergenceinitiative.org>), dedicated to advancing (neuro)science education and knowledge through art. I was fortunate to have the opportunity to co-instruct the Convergence course, a collaborative and transdisciplinary art-sci/sci-art course for graduate students of neuroscience (from McGill University) and undergraduate artists (from Concordia), hosted by Concordia and offered through the department of Design & Computation Arts. Working in teams, students mobilize knowledge through multisensory, multimodal artistic projects, exhibitions, symposia, and discussion panels. It felt natural to ask: How can art education and neuroscience reach across traditional disciplinary boundaries to provide a more nuanced understanding of creativity?³

Undertaking such an exploration using diffractive methods and a propositional framework was a formidable goal—one which guides this dissertation toward its theoretical approach. However, as an art educator, not a neuroscientist, I had moved my inquiry beyond the scope of my training. In an effort to strengthen my understanding, I enrolled in online graduate courses in neuroimaging⁴ and turned to the latest findings in NsC, using my association with the Convergence Initiative.

² The DCART 499/631 course and ARTE 432 became two sites for data gathering in this study and will be discussed in detail in Chapter 3.

³ Retrieved from <https://www.concordia.ca/sgs/public-scholars/alumni/2021/trish-osler/trish-osler-my-inspiration.html>

⁴ Offered through Johns Hopkins University via <https://www.coursera.org/learn/neuroscience-neuroimaging>

Neuroscientific research into creativity has become more refined over the past twenty years (Beaty, 2020) and is now better able to identify complex creative processes with greater accuracy, allowing us to challenge assumptions about the nature of creativity. When solving a complex problem, multiple networks in the brain are activated, as will be discussed in the ensuing chapters. These networks generate possibilities—some mundane, others seemingly unreachable, but all trying to make one key connection, a spark that illuminates the path to a solution. As my research unfolded, an exploration into artistic thinking processes that had begun at the master’s level⁵ extended to the very nature of problem-finding and inspiration, seeking ways to apply insights about creativity from students (in this case, art educators in training and students of fine art and of neuroscience) and to make that moment of inspiration, commonly referred to as the “aha” moment, easier to reach (Osler 2014, in press; Osler et al. 2019, 2022).

Current research points towards shared applications of the creative process across traditional disciplinary boundaries. New findings (Borgdorff et al., 2020; Fleerackers et al., 2022) suggest that art and neuroscience can work collaboratively to extend understandings of creativity, offering educators the potential to teach specific ways to access and develop critical and creative thinking skills. Inspiration is about making an unexpected connection to a long-standing curiosity or question, coming together in a sudden flash of insight (Boccia et al., 2015). But this “aha” moment is the product of a number of influences—some of which we can identify, like long term memory, and some we can develop, like mindfulness. Priming can increase the chances of making that connection (Minas & Dennis, 2019).

⁵ Osler, T. (2014). *Examining artistic process and transfer* [Master’s thesis, Western University]. <https://www.proquest.com/docview/2702486681?pq-origsite=gscholar&fromopenview=true>

As an instructor in Concordia's department of Art Education (2019–2021) and as a co-instructor with Convergence (2020–22), I designed priming activities with the goal that they might help me locate important connections to creative inspiration for students. For artists, this means breaking out of normal patterns, introducing new material or techniques, expressing complex ideas through a visual metaphor, or using counterfactual thinking like “what if?” (What if I did this, instead? Could I change an outcome by changing my approach?). Disruptive thinking strategies like these activate inspiration, and this, I believe, is a game changer for 21st-century teaching. In 2020–21, I focused on research sites where some of these ideas were examined and debated between arts and neuroscience students. Out of these learning activities and discussions, I offer and contribute a more transdisciplinary understanding of creativity that encompasses the arts, sciences, and other disciplines, transforming the purpose of this dissertation into a plan of action.

Figure 2

Diffractive Methods Demonstrate Interference



Photo credit: T. Osler

Note. Matter converges to produce new meaning, much in the way a painted colour chart will demonstrate changes in hue, intensity, and value as the material properties of brush, water, and substrate entangle with pigment in layers of colour meeting colour.

Chapter 1: Introduction

Purpose and Background

Creativity is endemic to all human endeavour, and yet we know comparatively little of the complex neural circuitry that gives rise to innovative thinking and problem-solving (Beaty, 2020). Creative capacity and creative processes, in general terms, have been identified by socio-cultural influences as fundamental to human progress and a desired outcome of learning in contemporary society (Piiro, 2021, p. 7). The implications for art educators are striking and, as defined by UNESCO’s Global Education agenda (SGD4) and Canada’s 2030 Agenda National Strategy, “Moving Forward Together” (February, 2021),⁶ are timely and relevant—predicated on the need for creative solutions, specifically for environmental and social justice challenges. As new information unfolds in the cognitive sciences and in particular the neuroscience of creativity (NsC), there is an opportunity to participate in, mobilize, and evaluate such findings from an arts perspective. For educators in the arts and for teachers of art education especially, possibilities abound that may help to illuminate complex processes regarding creativity in learning.

In the preface, I introduced how investigations into creativity were sparked by my own artistic curiosity and experience as a practicing arts educator in K–12 and post-secondary contexts. Focusing on relationships between art education theory and artistic processes, this

⁶ Jacques Delors (1996/2001) proposed to UNESCO “Four pillars of education for the 21st century,” comprising Learning to Know, Learning to Do, Learning to Live, and Learning to Be. Canada’s 2030 Agenda National Strategy (February 2021) outlines “a plan of action for people, planet and prosperity” consisting of 17 Sustainable Development goals, with the fourth goal, SDG4, devoted to education: “Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all” (2030 Agenda for Sustainable Development).

research takes up and challenges understandings of creative cognition emerging out of NsC and queries the interstitial spaces where artistic and scientific inquiry converge and intra-act to form new ecologies of practice and learning (Barnett & Jackson, 2020; Kemmis, 2012).⁷ Conceptually extending from the “practice architectures” of Wilkinson and Kemmis (2015), these ecologies of practice become contextual sites of learning for educators and students alike within art education. Such innovative and emergent spaces conjure a potential confluence of transdisciplinary areas of study critical for higher education and beyond. In so doing, this research underscores vitally important 21st-century skills (Delors, 1996/2001) required by next-generation learners, integrating, and mobilizing understandings of creativity both from neuroscience and art education theory to explore how each co-constitute an authentic, transdisciplinary model of artistic creativity.

At its core, art education theory is predicated upon an embodied engagement (Gouzouasis et al., 2013; Halverson & Sawyer, 2022; Irwin, 2004, 2013; Irwin & de Cosson, 2004; McNiff, 2018; Osler et al., 2022) among artist, concept, material, community of practice, and environment. Understandings of these relationships can be informed by research in other domains; neuroscientific research on brain function, for example, has recently identified patterns of neural network activation related to artistic creativity (Abraham, 2018; Beaty et al., 2016; Chatterjee & Vartanian, 2014, 2016; McPherson et al., 2022; Jung & Vartanian, 2018), leading to theories around the interdependence of multiple cognitive, affective, and sensorial processes. Interrogating the tensions between seemingly dissimilar approaches, both conceptually and performatively, offers insight into developing effective pedagogies that serve individual multiple

⁷ For more on “site ontologies” or learning that occurs at the “nexus of human practices and material arrangements,” see Schatzki (2005, p. 465).

domains as well as collaborative initiatives. By unveiling and incorporating these capacities, educators across disciplines, levels, and learning contexts enrich both pedagogy and curriculum for all learners.

For art educators in particular, the ability to make creative processes visible among learners offers access to intuitive, affective, and non-linear expression. For instance, neuroscience of creativity (NsC) research has theorized the concept of insight (inspiration) as an entanglement of dormant questions in long term memory commingling with new prompts to produce a novel idea (Gerver et al., 2022; Minas & Dennis, 2019). Within the creative entanglement, both the novel idea and the dormant question are transformed, suggesting that the disruption of an artistic problem with a novel and perhaps unrelated stimulus (such as working with a completely different prompt, material, or technique) unlocks new questions and creative pathways that address or reshape the original inquiry. A familiar example may be found in the artistic project that shifts rhizomatically while in progress, perhaps moving from a two-dimensional format to a three-dimensional format, or to a digital or sound-based artwork. Such transformations reshape the potential effect of an idea, while at the same time (like movements in a composition) retain traces of an idea that has expanded and re-shaped itself. Many participants in this study were metacognitively aware of such transformative moments, embracing iterative or altered outcomes as an inevitable entanglement of posthuman, exteroceptive, and interoceptive influences within the creative process.

The “force of art” (Atkinson, 2017, p. 2) then, lies not just in its social impact but in its unpredictable agency, the *becoming* process of creativity and the complex connections made through human and nonhuman encounters with material, memory, and affect, among other things. In Hellman and Lind’s (2017) re-imagining of arts education, the event of artmaking is

relational and dynamic, a coming-to-understand “encounters of objects, bodies and practices that, in their connectivity produce transformations” (p. 208; see also Duncum, 2015; Eisner, 2008; Grosz, 2001; Walker, 2015). Hence, the futurity of art education is regarded in transformative terms as educational assemblages with “components and connections that are constantly changing and moving” (Hellman & Lind, 2017, p. 208). For this reason, this research topic is aligned with what Borgdorff (2007) designates as “Research in the arts” in which “concepts and theories, experiences and understandings are interwoven with art practices” (p. 5). Where the creative process in art education is concerned, this theory-practice resembles Barad’s (2007) onto-epistemology, in which the study of creativity is through the experience of creativity-in-action. This understanding leads to the use of interventions inspired by NsC findings to observe and interrogate the embodied experience of creativity in art education.

Thinking Diffractively

Engaging with the complexities of creativity invites a diffractive method of investigation (Haraway, 1992, 2016), a method of overlappings and movement. In physics, movement conveys both propulsion and emergence, whereas in music for example, a movement is a convention that divides a larger scale of work into comprehensible pieces. When performed in succession with other movements, the whole of the composition can be understood. This is where the metaphor of movement in connection with diffraction transcends musicology, since through the formation of new understandings from movements that flow into one another, we come to appreciate the nuanced configuration of the rhythmic layers making up the essence of a composition. Each diffractive movement combines and recombines entanglements to form a new arrangement. With each diffraction comes a quickening, a plane of immanence (Deleuze & Guattari, 1987) by which

“knowing in being” (Barad, 2007, p. 185) gains momentum through transformation. Diffractive patterns form new lines of flight, “dis/continuous becoming(s)” (Thiele, 2016, para. 3), making visible the entanglements that are, as Murriss and Bozalek (2019a) remind us, “*always already there*” (p. 11).

I use a diffractive process to reveal or affirm pedagogies applicable to arts education as a way to move toward new pedagogical models and curricular modes of inquiry needed for productive futures in higher education. In doing so, I explore how discrete domains of art and science operate both in parallel and combined practices to query approaches that potentially lead to enhanced creativity and artistic thinking processes among learners in art education. As a methodology, diffraction engages different theories to disrupt conventional interpretations and to reveal insights into creativity that would be otherwise excluded by a disciplinary boundary (Bozalek & Zembylas, 2017; Dixon-Roman, 2016a). Two seemingly disparate domains performing together within an inquiry demonstrate diffraction in action and provide insights useful to a transdisciplinary understanding of creativity. An inquiry predicated on diffraction gathers insights by performing “agential cuts” that uncover the products of difference—in this case, the performance of creativity within and across domains, “a cut that is itself cross-cut” (Barad, 2013, p. 29) or a “cutting-together-apart” (Thiele, 2016, para. 10).

Thinking diffractively reconceptualizes the ontology of interpretivism, moving the researcher’s positionality from an interaction between humans to a posthuman *intra*-action of matter and materiality (Braidotti, 2016; Jackson & Mazzei, 2016). It is performative and nonrepresentational, “a material-discursive phenomenon that makes the effects of different differences evident” (Barad, 2007, p. 88). Material-discursive intra-activity recognizes a relational difference, not *from* but *through*, an entangled process of interference that activates

Barad's ethico-onto-epistemology of indeterminacy and Deleuze and Guattari's plane of immanence.

The design of this research is built upon revealing entanglements through assemblages of diffraction (see Table 2 below), combining theory and propositions with matter to reveal the inter-and intra-actions of participants. Intra-actions describe how a learner's relationality to process is altered by a creative encounter (Barad, 2007) and in this study, is mirrored in the intra-actions of artists, artist/educators, and artist/scientists shifting their epistemological stance through collaboration. Through tentacular and relational processes of becoming, the deleuzoguattarian concepts of affective/sensorial response, intensity, and affinity (Deleuze & Guattari, 1987) serve as key propositions for investigating creative processes in praxis and pedagogy. By opening spaces of inquiry, seeking not the differences between but the spaces between differences, I examine how creative thinking may be activated or supported through priming methods, locating a potential role for such methods in transdisciplinary initiatives where artmaking is a component of the curriculum, such as with art-sci/sci-art.

Propositions and Interventions

To investigate conceptual, processual, and performative artistic creativity in an art educational context, I diffracted theoretical propositions related to art education and posthuman theory through NsC, generating interference between the domains and developing pedagogical interventions. These, in turn, generate interference with the dispositions and process of the study's participants. Through diffractive combinations of learning interventions and metacognitive reflection, I interrogate how concepts relevant to the creative process asserted by

NsC translate to the experience of learners, both in art education and cross-domain (art-sci/sci-art) contexts.

Table 2

Assemblages of Diffraction and Entanglement

Diffractive Assemblages
<p>First diffraction → Concepts from Neuroscience of Creativity diffracted through Art Education Theory to develop interventions</p>
<p>Second diffraction → Interventions diffracted through participants in order to gather content for analysis</p>
<p>Third diffraction → Participant content through propositions to produce insights into the creative process</p> <p style="padding-left: 40px;"> proposition: interoceptive → intensities/affinities ← exteroceptive proposition: interoceptive → affect/sensorial ← exteroceptive proposition: interoceptive → process/relationality ← exteroceptive </p>
<p>Fourth diffraction → Propositions through research questions related to the interventions, the role of priming, and the potential for transdisciplinary processes</p>

Note. Entanglements of theories that foster interventions produce content, which is in turn diffracted through propositions and research questions to trace learner experience.

On a theoretical level, my inquiry investigates the entanglement of three propositions relevant to creativity emerging from art education theory: 1) intensities and affinities, holistic and dynamic place-based influences on the creative ideation; 2) affect and sensorial response evolving from ideation, and 3) relationality to the nonhuman or material engagement (Grusin, 2015). To this end, the creative and aesthetic processes of art(ist) teachers-in-training and student artists (some of whom also operate within the domain of science through art-sci/sci-art) serve as exploratory and site-specific interventions within two post-secondary courses. The first of these is among pre-service art educators in an undergraduate community Art Education course at Concordia University (ARTE 432), and the second, among Fine Arts undergraduate (Concordia) and Neuroscience graduate students (from McGill University) through the interdisciplinary Convergence course (DART 499/631), a hybrid art-sci/sci-art course delivered at Concordia.

On a performative level, this study examines the artistic experience of students engaging in creative activities that involve the planning, design, and artistic communication of ideas as a way to examine metacognition of the interoceptive (mindfulness) and exteroceptive (priming) influences asserted in the neuroscience of creativity. The efficacy of specific course activities or interventions for promoting divergent and convergent thinking, major components of creativity (Runco & Acar, 2012), advances distinctions in patterns of creativity and learning—enabling learners to actively and with self-directed autonomy uncover ways of disrupting their existing practices to increase the probability of novel and useful pedagogic connections. Revealing productive tensions between intuitive and metacognitive dispositions for learners also contributes to effective creative pre-work, leading to more satisfying insights (Minas & Dennis, 2019).

Specific Research Questions

My research questions specifically interrogate the following:

- How do pre-service arts educators and students of fine arts and neuroscience within an art-science collaborative respond to interventions predicated on the metacognition of creative processes?
- How does NsC research related to preparatory creative priming offer pedagogies and modes of learning for art education?
- How does collaborative investigation between art and science co-constitute transdisciplinary understanding?

The first question relates to the situational perception of pedagogies and activities as impactful aspects of the creative process. In this study, students experience and then reflect upon connections between the interventions and their own practice, offering insight into their own creative narrative. As students intra-act intuitively with activities designed to develop metacognition, the efficacy of the pedagogies begins to unfold, showing how interventions reveal the performance of particular phases of the creative process such as problem-finding, contextual research, insight, and prototyping.

The second question relates to the background of the pedagogies. Priming (task-related and non-task related pre-work) and disruption are supported by recent NsC research (Minas & Dennis, 2019) as useful strategies, increasing the probability for creative and resonant connections to be made. Participants explored problem-finding strategies by compiling image files, experimenting with techniques and materials, reviewing previous projects, consulting with peers, inviting collaboration, and conducting contextual research before arriving at a prototype. Interventions that involve gathering and producing self-curated priming materials were designed

as a way to discover whether targeted priming would increase metacognition and activate a positive affective state.

The third question queries the notion of transdisciplinarity and epistemological dispositions that are not domain specific. For example, the expression of creativity co-constituted across domain or disciplinary boundaries implies a shared, contextually negotiated ecology of practice. In other words, dispositions that exist both within and beyond a domain take different forms in different contexts and are re-formed in collaborative contexts. By contrast, the tensions implicit in differing perspectives may offer a beneficial resilience and accountability to each domain as well as to the shared inquiry.

It is perhaps useful at this point to mention that, epistemologically and germane to this inquiry, understandings of terms are not always congruent between the disciplines of art and science. For example, “proposition” holds different connotations for art education research than for science and technology studies (STS). Within artistic research, a proposition is a theoretical array of concepts through which an entanglement can be diffracted (Barad, 2007), whereas in STS it is a statement that can be verified or refuted (Vaage, 2019). Propositions (as they relate to this study) align more with an art education theoretical conception than with the scientific method. Similarly, “diffraction” (see Glossary) supports a propositional approach, as analysis is conducted through a theoretical filter with the intention of understanding how “positive difference” reveals the performance of an assemblage (see Murriss & Bozalek, 2019b, p. 3). Its meaning in this context is addressed more fully in Chapter 2, both in terms of its theoretical application to shared objectives of art education theory and STS and its methodological application to this study. The glossary of terms helps the reader distinguish the different meanings of words common to both domains.

Entangling NsC

Applying neuroscience to creativity in learning contexts is a complex but pedagogically compelling exploration. By entangling theoretical frameworks—even at the risk of language and methods fitting awkwardly together—more representative models of the creative process and dynamic, effective pedagogies and practices evolve. In this study, I investigate the interstitial relationships to creativity shared between the arts and NsC to inform my inquiry into potential transdisciplinary pedagogic approaches within art education. In other words, my interest in NsC is rooted in the potential for transdisciplinary creative dispositions to inform art education in new ways. I argue that, while neuroscientific understandings of artistic creativity are still nascent (Abraham, 2018; Beaty et al., 2016; Chatterjee & Vartanian, 2014, 2016; Dietrich, 2019; Dietrich & Kanso, 2010; Vartanian et al., 2013; Zhou, 2018), emergent assertions are important for art educators in order to reconceptualize the performance of creative praxis and its related pedagogies.

Acknowledging the challenges of decoding the creative process for artists, NsC research has diversified its investigations beyond simply detecting activation in the brain during creative work; it is interrogating the degree to which various interventions may alter creative capacity in individuals (see Beaty, 2020). Further, new technologies that allow for more specific testing methods for creativity have enabled NsC researchers to better replicate the conditions under which artists work. This research has the potential to confirm, dispel, or redirect understandings of the creative process, thereby making creative capacity more visible and accessible for all learners.

Critics argue, however, that locating connection points between NsC and pedagogy is fraught with the potential for reductionism. Leysen (2021), for example, asserts that neuromyths⁸ and popularized neurodiscourse oversimplify creative cognition, leading to “possible occurrences of conceptual confusion when moving from neuroscience to education” (p. 1). This is more of an appeal to caution when interpreting NsC research. Engaging NsC theory within the context of this study will help determine the speculative limits of (mis)appropriating conclusions across domains. Whereas Leysen’s (2021) “thought experiment” (p. 2) reduces collaborative contexts to instrumentalist pedagogies, a mitigating aspect within this study involves an exploration of art-sci/sci-art convergences to observe how these insights regarding creativity perform within transdisciplinary or cross-domain contexts. Refining existing pedagogies may help learners in art education and other domains meet the challenge of uncertainty during creative cognition, while incorporating the important processes of self-scrutiny, discovery, and experimentation that occur during the development of a creative response, including deciding when an artwork or project is complete.

Understandings of the dynamic connections that lead to creative cognition have provoked new ways of thinking about the multiple tensions and entanglements involved. To date, depictions of the creative process have been general and speculative in nature; while a foundational understanding of the progression from initial idea to completed project has been well documented (Finke et al., 1996; Lubart, 2001), exactly *how* specific connections are made between concepts remains unresolved (Abraham, 2018, pp. 35–36).

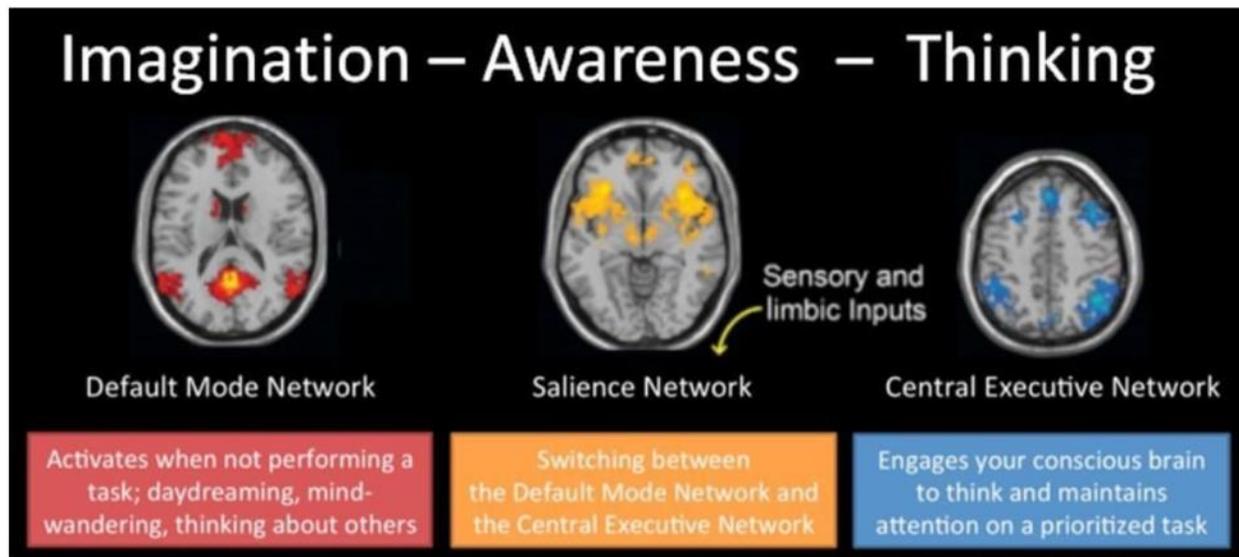
⁸ According to Howard-Jones (2010, p. 20), a neuromyth is “a misconception...a misreading or misquotation of facts scientifically established (by brain research) to make a case for the use of brain research in education or other contexts” (as cited in Leysen, 2021, p. 10).

Multiple agents are at play, stemming from insight, a generative component, an evaluative component, aesthetic considerations, the mood or emotional state of the artist, and the context in which the work takes place—such as environmental factors, individual versus collaborative initiatives, and materiality (see, for instance, Abraham, 2013, 2018; Beaty et al., 2016; Dietrich, 2004, 2019; Ellamil et al., 2012; Kaufman, 2019; Marron et al., 2018; McPherson et al., 2022; Mekern et al., 2019; Newton, 2013; Sowden et al., 2015, Jung & Vartanian, 2018; Yagolkovskiy & Kharkurin, 2016).

NsC research has mapped brain activity as the simultaneous operation of a series of neural networks. It is important to note that these networks are (neuro)plastic: “the neural mechanisms of cognitive processes are not static, they cannot be understood simply as fixed networks of regions [but are] constantly modified by experience” (Goldberg, 2017, p. 101). A simplified description of neural activity involves the interaction of three main networks of the brain (see Figure 3 below). The Default Mode Network (DMN) is associated with the generation of unregulated ideas; the Salience Network performs initial classifications (for example, relevance); and the Central Executive Network (CEN) performs a more nuanced, contextual analysis to reach a final decision (see Abraham, 2018; Beaty et al., 2015, 2022; Goldberg, 2018; Vessel et al., 2012).

Figure 3

Three Neural Networks in the Brain



Note. Processing tasks requires switching between self-directed interoceptive and externally directed exteroceptive thinking on the Default Mode Network (DFM) and the Central Executive Network (CEN) respectively. This switch in activation is regulated by the Salience Network (SN). © Creative Commons 4.0.

These networks operate in dialogic tension, where throughout the creative process the artist simultaneously generates and evaluates ideas. Abraham (2016) reveals that aesthetic activity within the brain informs *what* is generated by an artist and, at the same time, determines the purposefulness or utility of the working concept before it is even realized (p. 4206). Ellamil et al. (2012) confirm this tension, demonstrating that distinct areas of the brain are synchronously activated during creative work. The default mode network combines long-term memory with new information to generate ideas, while the other two networks search for and identify the most salient solution. Additionally, the default mode network, while remaining active, is regulated by the salience network, allowing more ideas (known as *fluency* in creativity research) as well as more disparate connections (known as *flexibility*) to be made (Ellamil et al.,

2012, pp. 1783–1785). For example, an artist may develop a range of process work for a project, aspects of which may be quite a departure from past practice. Sowden et al. (2015) posit that these processes are networked interdependently and suggest that an integrated model may be more reflective of the actual processes involved in creative cognition (p. 55).

In addition to *where* activity is occurring in the brain, *how* these networks interact has become more accessible to researchers (see Chen et al., 2020). Processes that extend beyond standard creativity tests such as TCTT, Alternative Use, and ARP spatial⁹ (see Kim, 2006) have become the new focus for creativity researchers in art, in education, and in neuroscience because these approaches map the geometry or shape of thought (Beaty et al., 2021), not just events that lead to creative “products.” Furthermore, current NsC research examines the space between semantic (or meaning-making) connections, while at the same time seeking new understandings of the creative events that lead to divergent thinking and how these events may be influential on a transdisciplinary level (see Guhn et al., 2020).

While creative thinking requires multiple neural networks operating at once, Abraham (2018) also specifies certain thinking strategies and dispositions in operation during creative work. Some strategies pertaining to the interventions introduced in this study include counterfactual thinking, the use of metaphor, and overcoming knowledge constraints with persistence and flexibility. (These strategies are described in the Glossary). Participants recounted, for example, that an encounter with unfamiliar materials was more stimulating than

⁹ The underlying assumption of the Torrance Creativity Test (TCTT) is that language flexibility is a reliable predictor for creativity. Subjects are asked to improvise words that complete a sequence. The ARP Spatial test is designed to assess visual creative ability; subjects are required to add to a random set of lines as quickly as possible to generate an image. The Alternative Uses Test requires subjects to imagine as many possible alternate uses for an item, such as a brick (see Abraham, 2018).

daunting since there was an anticipated cognitive reward associated with exploration, play and learning.

For the artist, the creative process is informed by multiple interoceptive (internal) inputs such as aesthetics, themes, values, and personal curiosity. These are combined with exteroceptive (external) influences such as engagement with materials, the environment, and physical interactivity with the artwork. The artist responds to various (and occasionally conflicting) interoceptive and exteroceptive influences, attempting to maintain the necessary creative tension—a state in which either fluency or flexibility operates effectively. An example of this might be when developing a concept from ideation to prototype: media, technique, form, and context are implicit or ignored by choice. Creative praxis maintains a generative and evaluative tension among these multiple influences in order to shift from a “state of ambiguity” to a “state of decision” or resolution (Abraham, 2016, p. 4206).

Achieving a state of *flow* (Csikszentmihalyi, 1975/2013, 1990) marks an immersive and dynamic experience in creative productivity that stems from complete absorption in the present moment where an “optimal balance” of capacity and opportunity emerges, shaped both by an individual’s intrinsic motivation and their environment (Nakamura & Csikszentmihalyi, 2009, pp. 195–197). In neuroscientific terms, flow is defined as “a state of full task engagement and low levels of self-referential thinking” during which sustained meaningful progress triggers a steady stream of reward impulses within the brain (van der Linden et al., 2021, p. 1). The satisfaction of being “in the zone” (a flow state) during creative encounters can be seen in participant comments like “*if I’m in the mood for it, I will work 10 hours straight on a project without break*” (Felix, DART 499/631), and

I become, like, hyper-focused on whatever I'm doing, but hyper-focused in a way that, like...everything else in my brain is just kind of...shutting down. Or it's kind of, you know, like something in there, my subconscious, is just...[Tallan gestures] but I don't really feel it. (Tallan, DART 499/631)

The evaluative criteria applied to the subsequent creative processes are developed out of a synthesis of cognitive, affective, and aesthetic influences (Mekern et al., 2019, p. 51). What might be described as intuitive or “felt” is quite likely the composite of these interoceptive (or internal) processes. Making these interoceptive and exteroceptive influences perceptible for an artist is a shared aim between researchers into creativity and arts education (Abraham, 2018; Hetland et al., 2007; Smith et al., 2022; Walker, 2015). Felipe, an artist participant and art educator in training, expressed his metacognition of creativity in multisensory terms:

I don't think creation is a simple thing. It's a mix of both, of getting out of your comfort zone, being content with yourself. Well also, a feeling in your hands, the brushstroke, for example, or feeling in your hand the drawing, the texture of the paper when you're using your colour crayon. I also have music going through my brain and for some reason, music will also generate memories at the same time. So, I would say that creation is a lot of 'overwhelmings', like, overwhelming stimulus. (Felipe, ARTE 432)

Developing metacognition of creative processes brings wondering (creative questions) forward to working memory, with the possibility of making new connections. This kind of connection is most evident in creative work when artists revisit decisions about a creative direction, delaying closure (Walker, 2004) to allow new possibilities to shift or entirely replace an initial inquiry. Study participants mentioned revisiting past projects and carrying forward

existing themes into novel creative work or revising partially completed work after a period of rest, as Mon recounts:

I have my Rubbermaid bin that I keep all my, you know, old sketchbooks in and stuff. So if I can find something in there and put it into something new—for me, that feels really good and useful. And I feel...I feel like it's doing justice to that project. (Mon, ARTE 432)

Interoception and Metacognition

Interoception relates to an individual's self-awareness and responsiveness to their own thoughts and feelings. While NsC research is valuable in confirming basic assumptions about how and where creativity operates within the brain, it has been shown to go only so far in explaining the student artist's *experience*, as the process of artmaking is not linear but iterative and recursive.

Mobilizing research into NsC for artists on an interoceptive level involves developing metacognitive awareness of one's cognitive and affective dispositions, especially the dispositions of curiosity and imagination. Lifelong curiosities, memories, and personal values emerge and re-emerge as thematic influences for an artist, creating spaces where the agency of a novel concept will engage with those dispositions. In their diffractive study of creativity, Chappell et al. (2019) relate how this agency will consciously, pre-consciously, or subconsciously affect subsequent choices made by the artist:

Tentatively this reference to feelings of different sorts might connect to what Reid (1980) called "knowing this" or "felt knowledge," of direct experience. This is related to aesthetic knowledge but is not specific to arts or sciences. It is a way of knowing that Reid argues needs to be educated for, alongside Ryle's (1949) "knowing that" (propositional knowledge) and "knowing how" (procedural knowledge). It is not

reducible to these two; it is conscious, immediate, intuitive, experiential, qualitative, in the moment knowledge. (p. 310)

Bringing dispositions forward metacognitively allows the artist and learner to query their creative approaches. To make creative dispositions more visible, Gallagher (2015) characterizes the composite of these dispositions as “aesthetic literacy,” both as a combination of *alignment*, a product of mindful perception and observation, and *attunement* (see also Triggs & Irwin, 2019), preparing the mind, heart, and body to engage with the environment and the materiality it encounters. Aligning and attuning perception, thoughts, moods, and physical self-awareness (Newton, 2013, p. 37) adds metacognitive awareness to the creative impulse. While each individual can achieve attunement in their own way, developing some or all of these dispositions requires a form of preparatory mindfulness practice as it relates to the given inquiry or context. Participants in this study described how “mood,” both positive and negative, was as important as insight in promoting or detracting from creative work, with comments such as:

I feel inspired usually when something has been, like, disrupted. Like, I haven't had enough sleep, I'm, like, in a weird frame of mind. I come up with things that I wouldn't have thought of had I been in, like, in a more rational frame of mind (Chanelle-Lize, ARTE 432).

Mon illustrates the connections between environment, mood, and insight for them: “*Light is very important to me because light is a big factor in my mood. Uhm, I...if I don't have a very lit up room, I get really sad. So, then I don't get anything done because I just feel all dark.*” (Mon, ARTE 432). These insights raise the question about the influences of mood on creativity, irrespective of inspiration. Developing interventions that increase metacognition serve to query the intersections of mood and insight and their connection to a creative process.

Exteroception and Priming

Neuroscientific research into creativity has identified the value of priming, or preparatory exercises, as a means of increasing both flexibility and persistence that shifts the artist toward a flow state (Minas & Dennis, 2019). Supraliminal (subject aware) priming relates to a stimulus or stimuli provided to spark and/or sustain the creative process. On an operational level, priming can activate bundles of long-term memory associated with an event or a category and move them into working memory, promoting increased creative potential. Priming is not limited to a particular domain or procedure: Minas and Dennis' (2019) research suggests that even task-*unrelated* priming activities, such as reconfiguring a workspace environment, have a positive influence on creative cognition. For example, I considered how artists and learners might respond to mindfully curating their own priming process in terms of their ability to create an ideal workspace, with choices pertaining to the location and layout of the space, visual or other sensory stimuli such as sound and light, and other material influences.

Research has also demonstrated that introducing *rarity* through divergent priming materials can be an effective component in singularly creative outcomes (Yagolkovskiy & Kharkurin, 2016, pp. 15–16). The more remote the priming material from the creative endeavour, the greater the likelihood of achieving novel concepts and solutions. Developing strategies to introduce the unfamiliar or provocative in a hybridized set of priming materials (task- and non-task-related) may prove to be the most useful component in stimulating creative practice (Marron et al., 2018, p. 51). Furthermore, the development and use of a priming set, especially in the early stages of the creative process, may increase the opportunity to achieve a flow state.

Out of these insights, I developed and incorporated learning interventions in art education and art-sci/sci-art convergence contexts. Priming-related practices are not unfamiliar to artists

and educators, who intuitively construct priming media and methods such as image files, preliminary sketches, mind maps, and prototypes, playing with media and materials. Learning interventions containing these concepts are diffracted in learning contexts with the participants.

Transdisciplinarity

In this study, *transdisciplinarity* is interpreted as processes common to different domains: in this case, art and science through art education and art-sci/sci-art. The synergistic potential of two or more domains, operating in concert for a purpose that incorporates knowledge acquisition and mobilization, results in a broader socio-cultural scope that extends beyond the contributions of each discipline: “where the outcome extends beyond interdisciplinary approaches to create something completely new, providing space for social transformations as well as governance ones” (Paterson et al., 2020, p. 2). In addition, both art and science provide avenues for enquiry and communication, impacting different audiences through generating a multiplicity of resonate narratives (see Patrizio, 2020). Collaborative inquiry design requires an exchange of ideas—either to arrive at a common understanding or effectively employ tensions and restrictions inherent in a collaborative context to elevate the accountability of the inquiry.

Paterson et al. (2020) summarize the discourse about transdisciplinarity by concluding that “combined collaborative arts and sciences projects can enhance transformations by encouraging decision making that engages with emotion and intuition as well as cognition as a motivation behind change” (p. 4). Optimally, they operate to activate change within the inquiry as well, “including the creation of participatory and discourse spaces that generate evidence and enable transformation in practice” (Paterson et al., 2020, p. 3). What the arts bring to transdisciplinary approaches in art-sci/sci-art extends beyond conveying scientific findings in a

more accessible manner. It co-creates a discourse that incorporates or elevates values in tandem with facts to add depth to an inquiry (see Montuori, 2011). In short, as a counterpoint to perceptions of transdisciplinarity, “most creators expressing the ‘two disciplines’ theme...[see] art and science as complementary ways of knowing” (Paterson et al., 2020, p. 13), but in ways that also welcome value-driven input from a variety of stakeholders.

Diffraction Method of Inquiry

Diffraction seeks to reveal insights through multiple entanglements of researcher, methodology, and inquiry context, providing a more authentic depiction of how multiple phenomena perform together and/or are transformed by the inquiry process. In this inquiry, I interpose art education theory and neuroscience of creativity concepts into the creative process as diffractive filters. Given that diffraction operates at the threshold of theory and methodology, there is some overlap across chapters, and this is emblematic of what it is to think diffractively.

As a method, qualitative and arts-based artifacts of diverse media may be diffracted together to offer insights not readily available to predictive or hypothetical theorizing. For example, I developed interventions asking participants to develop both task-related and non-task related image files to support the activation of long-term memory, a key component of creativity (Gerver et al., 2022; Minas & Dennis, 2019). Through a series of diffractions, the process becomes iterative, permitting multiple layers of insight (and uncertainty) to accumulate; and flexible, embracing both anticipated and outlying expressions to emerge.

The advantages of a diffractive approach in this context are threefold: it simultaneously acknowledges and disrupts researcher bias by involving theory-based filters through which the gathered content is considered. It does not intend to offer a definitive understanding of how

domain-based conventions of science and art research are transformed through their encounter in this study, yet the initial diffraction of parallel concepts provides a guide for producing meaningful interventions. Further, it requires attentiveness to difference, outliers within the participant content, and artistic creative processes that point to aspects of matter and meaning.

Diffractional matter for this inquiry was gathered from three sites through semi-structured interviews, student artistic responses, reflections, artist statements, visual journals, and field observations documented during pedagogical interventions. Data-gathering incorporated qualitative arts-based approaches relevant to decoding possible differences across sites. For example, semi-structured interviews probed perceptions of efficacy among students who participated in activations. Anecdotal participant reporting adds breadth and depth about the narrative experiences of student artists, whether from art education or art-sci/sci-art; essential, for this study, in determining where disciplinary or domain-specific frames of reference influence perception.

Multiple factors influenced my selection of site and subject. With the intent that this research benefit art education, and considering my position as an instructor in an art education setting, the context was suitable to access material from ARTE 432. Exploring the nature of transdisciplinarity in action was facilitated by making the most of the exchange between fine arts/design undergraduates and neuroscience graduate students from the Convergence DART 499/631 course. As most participants from this second site identified as artists (even though some concurrently operate within the domain of science), I considered their intra-actions within an art-sci/sci-art context to be equally relevant. The interest that artists who are also educators share with artists who are also scientists in seeking out perspectives shaped by entirely different domains suggests that ecosystems of inquiry and ecologies of learning and practice benefit from

the intersections of diverse elements (see Beaty, 2020; Borgdorff, 2020; Yagolkovskiy & Kharkhurin, 2018).

At the two principal sites, I employed a diffractive analysis as an artist/educator positioned *within* the inquiry, applying the same metacognitive processes and documenting my own practice as both courses progressed. Drawing from Barad's (2007) comparison of diffraction with the practice of reflection as a methodology, Bozalek and Zembylas (2017) claim that "to engage in diffractive analysis means to study the practices of knowing as they are enacted in the materiality of the world, in a state of interdependence with other parts of the world" (p. 118). Opening up data by letting voices "speak for themselves," as Lenz Taguchi (2012) informs us, is a "process of co-constitution, inviting the entanglement of ideas and other materialities in ways that reflexive methodologies do not" (p. 271).

I diffracted the content collected through the interventions and interviews multiple times, using the findings of each diffraction to inform the next phases. Bringing multiple readings to a concept or phenomenon serves to repeatedly co-constitute both the researcher's understanding and the phenomenon in unanticipated ways, resulting in a more authentic complexity of engagement. An example of a related process-based methodology is found in Jackson and Mazzei (2018), who articulated the "thinking-with theory" approach as a more flexible analytic of qualitative inquiry. This methodology eschews the traditional model of data collection and analysis, and to a point, even the recursive, iterative forms. The goal within a new empirical framework is to develop a "new analytic," one that forms "dynamic becomings and generative differentiations" (Jackson & Mazzei, 2018, p. 719).

Art education is well-placed to navigate, transgress, and re-imagine traditional educational boundaries. Although the influences of NsC and transdisciplinarity offer diffractive

filters, art education theory informs the propositional framework (see Table 3 below). I have structured my investigation propositionally to entangle NsC concepts with those advanced by poststructural theorists (see Barad, 2007; Deleuze & Guattari 1987, 2009; Haraway, 1997, 2016). In so doing, assemblages of data and concept have been diffracted to illuminate congruences and incongruences relevant to a more robust conception of the creative process in art education. Emergent trends in participant content, as well as outliers, were diffracted through both NsC theory and the concepts of *désire*, *encounter*, *the plane of immanence*, *nomadic thinking* (Deleuze & Guattari, 1987), and *tentacular thinking* (Haraway, 2016). Course-based initiatives, including preparatory and reflective exercises and practices, were developed and enacted with participants in order to query these components of the creative process in a lived context.

Table 3

Entanglements: Propositions, Art Education Theory, and NsC Concepts

Propositions, Art Education Theory Concepts, and NsC			
Interoception	Exteroception	Related Art Theory Concepts	Related NsC Concepts
intensities	affinities	<i>désire</i> , plane of immanence	long-term memory, priming, rarity
affect	sensorial	nomadic/ tentacular thinking	mind wandering, hypofrontality, experimentation
process	relationality	encounter	insight

My aim is to affirm through these diffractive approaches that creativity is the product of an encounter between the known (familiar) and the novel, and that it encompasses human and nonhuman/more-than human experience. It is at once *supranormal* [emphasis mine] as Massumi (2015) posits, and entirely normal (ubiquitous). The aim of this inquiry is not to demystify and neutralize the benefits of the supranormal behaviour but to engage a multiplicity of lenses to reveal transdisciplinary processes of artistic creativity and the pedagogies activating them. In this way, multiplicity becomes an ongoing process of combining and re-combining assemblages to fully articulate, provoke, and map resonant aspects of the creative experience, offering relevant pedagogies for 21st-century learners that push the boundaries of current educational philosophy, theory, methodology, and practice.

Possible Limitations to this Study

Scope

First, the scope of this study is limited to the selected dispositions and processes that have been identified to date in NsC and their applicability within art education contexts. The research is informed by NsC and transdisciplinary contexts, but NsC remains limited in its ability to advance transversal pedagogies for new spaces of exchange. Likewise, while merging propositional, contextual, and conceptual elements through an iterative diffractive process queries transdisciplinary creative activities, a comprehensive discussion of transdisciplinarity lies beyond the scope of this research. In response, I have focused on transformative possibilities found in NsC in the context of art education and, to a lesser degree, on the potentialities for transformative encounters within art-sci/sci-art collaborative contexts.

Second, this inquiry is theory-based; while qualitative methods for data gathering permit a relatively small sample, 17 participants examined over a period of 13 to 26 weeks in the context of class activities cannot ensure trustworthiness across all learning contexts. My proximity as a course instructor to the learning sites and learners enabled me to observe the practices of students and, where possible, their participation in the learning interventions in advance of the inquiry. This familiarity, however, may result in foregrounding perspectives about the creative process that align with my own, even though my own observations and accounts are diffracted within the analysis. I employ multiple diffractions to include outliers within the findings.

Assumptions About the Creative Process for Artists and Educators

This study does not attempt to perform research into the neuroscience of creativity; rather, it seeks to explore, affirm, or challenge its current assertions about creative practice specifically related to visual artists (and, by extension art educators) in learning and lived contexts. While generic models of the creative process are well-documented (see Abraham, 2018; Amabile, 1983/1995; Lubart, 2001; Mednick, 1962; Sadler-Smith, 2015), creativity in the visual arts poses specific challenges. For instance, language-based tests for creativity do not demonstrate a strong correlation with visual creativity (Smith et al., 2022). Evaluating artistic creativity cannot, therefore, be achieved in an entirely objective manner. Pre-determining criteria for adjudicating creativity poses a challenge even for art educators, as this assumes there are objective standards that can be identified and met. While interventions and experiments may report changes in creative ability (Smith et al., 2022), the results are applicable only within a very limited definition of creativity. For this reason, creativity within art education may be revealed more effectively and meaningfully across the scope of an entire inquiry, from ideation

to sharing. I found it more purposeful, therefore, to explore how creativity *performs* within art education and art-sci/sci-art collaborations.

Timing of Study

Given that data gathering occurred during the COVID-19 pandemic in the late spring of 2021, this posed some minor limitations on consistency and continuity. During this period of adjustment for course delivery, students and teachers moved to remote platforms, altering how students collaborated during the creative development process. For example, the multisensorial nature of art production and process was shared in more limited ways, with virtual rather than in-person exhibitions of student work. In addition, online attendance was challenging for some as internet instability was a deterrent. My personal notations are indicative of the lived experience of remote teaching and learning at that time and the impact it was having both on me and on my students:

[As a teacher]...detecting the less visible [in students] is challenging: important signals like body language, the brightening of a student's face in a moment of recognition, even apprehension (or is it fatigue?) are harder to see on the screen. In order to convey all that is needed in this space I dial in to in-betweenness—a new kind of immanence... 'I hear you' (even though you hesitate to speak in this forum). 'I see you' (even though you are disembodied). 'I welcome you.' My spoken invitation is only the first demonstration, creating space for trust to grow, but it doesn't feel enough. Despite the online camaraderie, I sense a weariness (wariness?) amongst the students. The spotlight of the camera feels intrusive. Still, we are curious to see where this will lead; that small thumbnail [in Zoom] is an insufficient proxy for twenty-two individuals. [personal communication, September 23, 2020]

A month into the semester, I could sense a shift. Together, we had begun to overcome some of these challenges, learning to convert the limitations of virtual classroom exchange into opportunities for growth and new ways of communicating:

At first, we all fumbled and awkwardly laughed at our attempts to screen share fluidly. With practice it has become easier, using the screen as a whiteboard, where ideas are sampled through sticky notes. Still missing, however, is the space for nuanced messages, the kind implicit in an exchange of glances, a nod of the head (replacement for fist bump), a smile of encouragement. I want these in-person messaging habits to transfer seamlessly to virtual delivery, but as I play back [the recordings of] my classes, I catch a glimpse of myself on the periphery of my own screen. My silent supportive tics seem untranslatable. The chat thread has become the space where important subtext happens; emojis are now important signposts for personal expression. [personal communication, DART 499/631, October 2020]

These factors, however, did not significantly impact my diffractive inquiry, as materials gathered from course recordings provided audiovisual documentation of activities and digitally captured artistic outcomes. Students had learned over the duration of these and other remotely delivered courses to share their thoughts in such collaborative online contexts as written discussion forums and group chats, documenting and depositing visual records of their process work into folders in Moodle or Google Classroom for discussion at the ensuing class. Being open to limitations and discovering new possibilities for entanglement within the creative process entailed re-examining the use of field notes as a way to account for variances in intervention delivery and debriefing activities, bringing my own accounting as both teacher and researcher into the process.

Overview of Chapters

In the following chapters, I diffract learning interventions developed from arts research (Guhn et al., 2020), arts-based research (Blair, 2020; Gouzouasis et al., 2013; Irwin, 2013; Irwin & Springgay, 2008; Leavy, 2018; Sinner, 2017, 2018), and NsC research (Abraham, 2018; Beaty et al., 2022; Dietrich, 2004, 2019; Ellamil et al., 2012; Goldberg, 2018; Green, 2016) in order to 1) investigate the scope of inclusive dispositional processes and praxis of embodied artistic and aesthetic perception as a mechanism to assess, implement, and evaluate priming, rarity, metacognition, and the learning impacts of collaborative engagements; and 2) articulate future pedagogic models, modes of methodological inquiry, and theoretical constructs that are shaping post-qualitative paradigms. As the researcher, I apply theoretical readings to an assemblage in order to interrogate how the component entities relate to their context. For this reason, my research is more an enactment than a conventional, qualitative, methods-based process.

Chapter 2 provides a review of current literature to establish the scope and context for this study, situating it within the field of scholarship on the topic. Four theoretical ribbons of thought are configured as a way to structure intertwining theories behind diffraction, NsC, art education and STS, and posthuman concepts within the feminist philosophies of Deleuze and Guattari and of Haraway in relation to the propositions.

Using a diffractive framework with an exploratory integration of neuroscience necessitates a brief discussion of each domain, highlighting the intersection points relevant to this inquiry. Diffraction as a framework and a methodology warrants attention as it confers theoretical posthuman agency, especially in terms of its capacity to offer a threshold between two domains where transdisciplinarity may occur, and an ability to situate the researcher within an

assemblage. The configuration of propositional concepts diffracts art education theory, posthuman theory, and the neuroscience of creativity.

Thinking *with* theory across domain boundaries honours the intent to allow the research to achieve its own agency within an assemblage. In this case, the concepts of Deleuze and Guattari (1987, 2009), Deleuze & Parnet (2007), and Haraway (2016) were selected as they propose concepts of thought, including creative thoughts more congruent with neuroscience of creativity theory (Abraham, 2018). For example, concepts such as *nomadic* (Deleuze & Guattari) or *tentacular thinking* (Haraway) correlate with the non-linear function of neural networks, which draw on multiple sources in the brain to form thoughts and ideas. Finally, interrogating the discourse on creativity in art education, particularly aspects involving metacognition of the creative process, offers reference points for the pedagogies and interventions applied in this study.

Chapter 3 outlines the nature, scope, and scale of the study itself. Here, I elaborate on the diffractive methods used in the study, the pedagogical interventions (priming activities), semi-structured interviews, student journal entries and artist statements, and my own personal reflections as the researcher. In the first diffraction, I demonstrate an entanglement of concepts from art education theory diffracted reciprocally through parallel concepts from NsC (such as priming and rarity), while in the second diffraction, I include multiple examples of participant content diffracted through the interventions that sprang from Diffraction 1.

Chapter 4 begins with the third diffraction, wherein relevant participant content from visual journal entries, interviews, and my own observations are read through the propositions organized along the stages of the creative process. For the pre-conscious problem-finding stage, I diffracted intensities/affinities, followed by the ideation and research phase within the

affect/sensorial proposition. Insights, including outliers or “glow moments” (see MacLure, 2013, p. 660) for each of these propositions, inform a review of the creative process by diffracting process/relationality. The fourth and final diffraction involves insights emerging from the propositional diffraction through the research questions.

Chapter 5 discusses the results of diffractive analysis in determining the suitability of the classroom activities and contexts in which they might be applied, reimagined, or replaced. Queries arising from multiple diffractions that combined the original propositions and their effectiveness in answering each of the research questions are explored. These questions bring new understandings about the nature of artistic creativity, serve as possible launching points to further the discourse within educational contexts regarding discipline-specific and transdisciplinary creative processes, and prompt areas for further research and discussion.

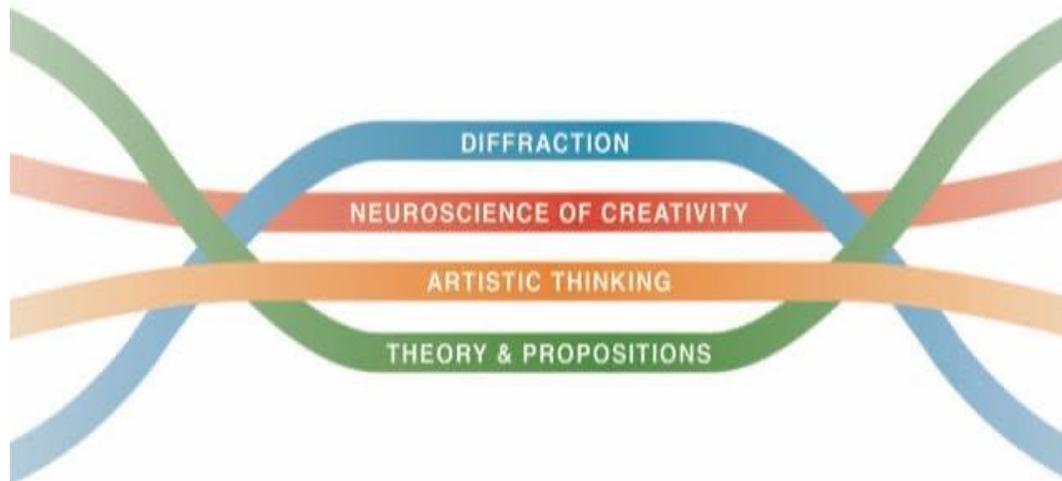
Chapter 2: Diffractive Perspectives

It matters what thoughts think thoughts (Haraway, 2016, p. 35).

This chapter defines the diffractive theoretical framework that combines conceptions of creativity revealed in NsC theory with philosophical concepts found in art education. Additionally, through a review of art-sci/sci-art discourse, I explore the nature of transdisciplinary dispositions of inquiry and how domain-specific conventions and methodologies interact together, given that any understanding of creative cognition or creativity in action is intended for application in an art educational context. The chapter is divided into four sections that overlap and entwine together as interwoven and *intra*woven ribbons of thought leading to new thoughts. This is a way of diffractivating theory, entangling it both structurally and rhizomatically with the propositions presented in Chapter 1 and through the methodology set out in Chapter 3.

Figure 4

Entangling Ribbons of Thought



I use a ribbon metaphor to provoke in the reader's mind a *metissage* of theory-in-relation, weaving the four strands as follows to consider each in relation to artful practice and to one another: 1) a discussion of diffraction as a post-qualitative theoretical approach within the posthuman turn (Barad, 2007; Haraway, 1992); 2) a review of relevant research on the neuroscience of creativity, particularly the influences of memory, metacognitive priming, and domain expertise on creative practice; 3) where intersections with creative cognition in relation to art education and science and technology studies exist, and 4) a selection of theoretical concepts applied in art education from Deleuze (1994) and Deleuze and Guattari (1987, 2009), including Haraway's (2016) conceptual portrayal of creative thought and their relationship to the propositions presented in Chapter 1.

Ribbon 1: Diffraction and the Posthuman Turn

The posthuman turn (Barad, 2007; Grusin, 2015; Haraway, 1992; Manning, 2015) emerged out of poststructuralist discourse (St. Pierre, 2013, 2019), reshaping ontological and epistemological understandings of being and knowing by challenging traditional understandings of the nature of matter and how it is experienced. As *being* (becoming) is indivisible from *knowing* and *doing*, the effect of an event or process is not reducible to a single representation (Davies, 2017; Grusin, 2015). Within the posthuman turn, humans are not distinct in nature from the nonhuman; they are incorporated into a complex, interdependent, and rhizomatic web of being, with each component having agency—whether flora or fauna, ecosystems, technologies, or pedagogies (see Haraway, 2016; Taylor & Hughes, 2016).

Furthermore and related to creativity, Massumi (2015) contends that this agency—rather than being predictable—can be expressed in a “supranormal,” improvisational manner, the product of the processes of entanglement “oriented toward a spontaneous excess of creative self-consistency” (p. 8). For humans, according to Manning (2015), this excess is expressed through the practice of art and the engagement of creative intuition as a dispositional, process-based means of intra-action with(in) the nonhuman: “It is not the human but the art that has become capable of activating or generating an event-time that invents with the forces that exceed our humanness” (p. 65). Jackson and Mazzei (2016) assert that “agency is not attributable to any one thing, but rather bound to an assemblage” within which “human actions are only one force” (p. 94). For educators, developing metacognition of systems, processes, and pedagogies and the agency they hold establishes an ethical responsibility or “response-ability” (Barad, 2010) regarding the learning encounters they co-constitute.

Both the foregrounding of the posthuman on a theoretical level and the attendant shift in understandings of research as a whole have implications for this inquiry. The ethical implications of a world that transcends humanist centrism enhances both theory and practice in terms of social (human to human) and environmental (human to nonhuman) justice, while diffractive “thinking with theory” approaches to research (Jackson & Mazzei, 2018) align with and extend art education research practices.

Diffraction, as both a theory and a methodology within the posthuman turn, decentralizes the subject/object binary between humanity and the universe it inhabits. Building on feminist scholar Trinh Min-ha’s (1986) concept of “inappropriate/d Others,”¹⁰ Haraway (1992) first proposed the methodology of diffraction as an “alternative to epistemological practices of reflexivity grounded in representationalism” (as cited in Bozalek & Zembylas, 2017, p. 111). A diffractive approach acknowledges the interdependent and entangled multiplicity of relationships that reveal an embodied agency among ever-evolving components, situating the researcher as a co-constitutive component of knowledge rather than as a reflective (or critically reflexive) interpreter representing processes or phenomena (Bozalek & Zembylas, 2017, p. 117).

Diffraction applies the concepts of a material-discursive approach (matter and language together as co-constituents of ontologies) and transcorporeality (understanding as emergent from a holistic engagement within an entanglement of researcher and inquiry) (see Lenz Taguchi, 2012). The process of inquiry is co-creating *with* the wondering, examining these processes which “are not manifest in themselves but that become temporarily manifest through this practice” (Lenz Taguchi & Palmer, 2013, p. 674). The implications of this shift in conceptualizations of research are important to the context of this inquiry because I am

¹⁰ The notion is that “reflection keeps what is reflected on at a distance” (Iliadis, 2014, n.p.).

implicated in the assemblages as instructor, as participant, and as a researcher moving fluidly between roles, selecting diffractive filters and gathering insights around the performativity of the creative process, in-the-moment through the interventions and through participant reflections of their process. In diffraction, one relies on these theory-based filters to observe the assemblage from and within multiple perspectives.

To translate these understandings into practice, diffractive theorists (Barad, 2007; Haraway, 1992, 1997, Lenz Taguchi & Palmer, 2013; Murriss & Bozalek, 2019a, 2019b; van der Tuin, 2013, 2019) generated a methodology for reading “through” assembled media (or assemblages) gathered during an inquiry, usually employing philosophical theories and theorists selected by the researcher. Barad (2007) proposed reading-*through* different texts and theories instead of reading hierarchically—that is, reading only discipline-based background or theoretical texts.

Taking this up, Dolphijn and van der Tuin (2012) extend the discourse: “A diffractive methodology is... a detailed, attentive and careful reading of the ideas of one through another” (2012, p. 50). In this way, the researcher engages temporal and spatial considerations as well as partiality to reveal how an assemblage *becomes* differently during each reading-through. This process offers a context through which to view temporary ecologies that may differ from a subject-object binary, allowing the ontologies to form, dissolve, and reform in different ways to offer a richer complexity within the entanglement.

Dixon-Roman (2016a) summarizes the flexibility that diffraction brings to a transdisciplinary inquiry:

diffraction is a transdisciplinary approach of putting the theories of different disciplines in conversation. ... The intention is to pay particular attention to the boundary-making

processes of each disciplinary theory and the ways in which one might rescue, recover, recuperate, or illuminate the other; making visible that which was excluded by the boundary-making practices of the disciplinary theory. (p. 6)

Ethically and ontologically, the researcher is responsible for boundary-making that occurs: “It is upon this ontologically co-constitutive and ethical relationship that the diffractive patterns depend” (Lenz Taguchi & Palmer, 2013, p. 684). As such, the challenge for the researcher is to diffract multiple assemblages of an inquiry through theory to mitigate assumptions stemming from their bias. It requires the researcher to disrupt their own established approaches and preferences, and allows concepts, data, and participating agencies to choreograph their own encounter.

Paralleling the re-conception of matter as an assemblage of agencies, diffractive approaches situate the researcher *within* the event-encounter, which combines and recombines the gathered ephemera by applying Barad’s (2007) suggested reading-through methodology. The researcher’s position of primacy is re-attuned, one thread in the weaving of a whole—a thread which, through the process of combination, is at once both transformed by and through the performative ontologies within the assemblage. The researcher’s agency is acknowledged throughout each phase of the encounter, from the initial curiosity to the selection of the apparatus (Barad, 2007) or *machine* (Deleuze & Guattari, 1987, p. 4), “but also on the differences that get made in ... embodied engagements with these data” (Lenz Taguchi & Palmer, 2013, p. 675).

Haraway (2016) stresses the importance of the choice of materials for diffraction by contending that “it is important *what* thoughts think thoughts” (p. 35, emphasis added). As contexts for inquiry change, so too might the performance of a phenomenon change; therefore, the selection of theory must be done mindfully. Aligned with a diffractive approach, a

poststructuralist inquiry recognizes that 1) a phenomenon is an assemblage, rather than a product, of myriad relations encountering it; 2) the performance of a phenomenon is mutable and (self-)altering when examined from multiple perspectives; 3) the researcher acknowledges their own presence and the agential nature of the apparatus they employ throughout the inquiry (in this case, the agency of the theory used to diffract); and 4) inquiry aims not to represent what an object or phenomenon *is* at any given point, but rather what it *does* (how it performs) under a variety of circumstances (Hellman & Lind, 2017).

A diffractive methodology attempts to disrupt preconceived patterns of exploring phenomena by intentionally combining practice with different theories or concepts to arrive at *difference*. In defining diffraction, Barad (2007, 2014) asserts an expression of relationality akin to the quantum physics of individual waves overlapping one another, and the phenomenon that occurs when waves encounter an obstacle, causing new patterns of diffraction as they converge and reshape into new formations. These “patterns of difference that make a difference” (p. 72) challenge assumed perspectives, as with a researcher pursuing an inquiry. Rather than ignoring or excluding emergent outliers within an inquiry, a diffractive approach seeks to disrupt conventional interpretations, paying closer attention to these outliers as they provoke new questions within the inquiry:

Difference is seen in an affirmative light, as a tool of creativity, rather than as separation or lack. Difference here is not positioned as the opposition to sameness—but is also incorporated into the self as difference within and seen as a means of becoming.

(Hellman & Lind, 2017, p. 215)

The aim of diffraction is to identify this ongoing difference which forms the becoming of the assemblage and its entities, looking for “effects of difference” rather than merely differences.

(Haraway, 1992, p. 300). Effects are the results of the process of an assemblage, not its co-constitutive components. Diffraction involves the intention to illuminate and challenge an inquiry, applying diverse theories within an event-encounter to provoke unanticipated connections.

The complexity inherent in the study of creativity in art education requires a framework that engages the performativity of creative processes from within. Diffraction permits an embedded and embodied unfolding of understandings with the guardrails of art theory on one side, breached by interventions developed through NsC on the other.

Ribbon 2: The Neuroscience of Creativity

Diffraction concepts from neuroscience of creativity offers a remote yet related perspective for encountering the ephemeral nature of creativity within art education. Over the past decades it has become evident that, even without NsC input, arts education has made efforts to identify and cultivate the dispositions and skills perceived necessary to develop creativity. Concepts such as “problem-finding and problem solving” (Dudek and Cote, 1994), “cognitive complexity” (Stalker, 1981), “being attentive” (Blair, 2020), “intensity of application,” “early mastery of cultural forms” (Pariser, 1997), and “taking risks, being empathetic, posing problems, thinking flexibly and interdependently, persistence and metacognitive thinking” (Zimmerman, 2009) have all been theorized as germane to creative development. Feldhusen (1992) and Treffinger (1995) theorized that many of these traits could be taught, or at least students could become metacognitively aware of the necessary dispositions to improve creative inquiry (Hetland et al., 2007). The skills and dispositions mentioned here begin to coalesce around

models of the creative process, but the existing research lacks specificity around pedagogies to foster creativity.

NsC and related research into creativity offer entry points into the question of how artists think. The complex networked and non-linear interplay between interoceptive and exteroceptive processes allows the artist to move from ambiguity to creative resolution (Minas & Dennis, 2019). These assertions find some congruence with a theoretical framework predicated on the entanglement between the human, the nonhuman, and the more-than-human as a means of exploring knowledge. To locate NsC in the context of this inquiry and the pedagogies that may be operationalized in art education, it is helpful to first understand what is meant by creative cognition.

Creativity, the study of which has a long history and breadth of definitions, is generally considered to be “the production of ideas and objects that are both novel or original and worthwhile or appropriate, that is, useful, attractive, meaningful, or correct” (Oxford Dictionary of Psychology, 3rd ed., 2014). While the study of empirical aesthetics goes back to the 19th century,¹¹ creativity research spans several distinct domains. Over time, creativity was defined not only in terms of its genetic basis as a neurobiological process, but also as an idea or concept, and even as a product (Csikszentmihalyi, 1975/2013, pp. 25–26). Still, cognitive neuroscientist and clinical neuropsychologist Elkhanon Goldberg (2018) cautions us to regard creativity research in light of two parallel narratives: the cultural perspective, such as that put forward by

¹¹ See Gustav Theodor Fechner (1801–1887), the physicist, philosopher, and psychophysicist who wrote the foundational *Vorschule der Aesthetic* (1876).

popular creativity theorists,¹² and the neuroscientific study of divergent thinking. According to Goldberg (2018), the many ways in which we understand creativity is one reason for the complexity and volume of research in the field, accounting for the limitations in our ability to deconstruct it. Measures of creativity can be both expansive (such as “imaginative,” “original”) and narrow. No matter what form it takes, creativity is not a primary cognitive attribute; there is no one creative “zone” in the brain but rather a derivative attribute (Goldberg, 2018, pp. 196–97), one that depends on the interaction of different cognitive and neural functions coming together through a dynamic process of network connectivity (see Figure 3).

Most neuroscientific researchers concur with Runco and Jaeger’s (2012) view of the defining standard for creativity, in that it requires both *originality* and *usefulness* (Stein, 1953).¹³ This two-criterion definition is interchangeably referred to in NsC as “novelty” and “purposefulness” (Runco & Jaeger, 2012, p. 92). In general, novelty is awareness of a connection that has not previously been brought into consciousness. Purposefulness relates to the way in which the learning contained in the ideation advances the context in which it is produced (Abraham, 2018; Goldberg, 2018; Sternberg, 2006. Interestingly, Simonton (2012, 2018a, 2018b) added to Runco and Jaeger’s (2012) definition, identifying *surprise* as a third criterion for creativity. But he asserted it is not the sum of originality + utility + surprise that defines creativity; rather, it is the “multiplicative” (2012, p. 98) integration of the three criteria. In other words, “a totally useless idea can still be highly creative provided it is extremely original and

¹² See, for example, such cultural creativity theorists as Edward de Bono (1995) on “lateral thinking,” Mihail Csikszentmihalyi (2013) on “flow state,” and Robert Root-Bernstein and Michele Root-Bernstein (2001) on cognitive thinking tools for creativity.

¹³ This standard was originally proposed in an article on creativity and culture by Stein (1953). See also Barron (1955).

surprising” (2018a, p. 80). Simonton (2018a, 2018b) illustrates this opinion with the impracticable (but creative) example of a bank safe constructed of Styrofoam or cellophane, or even more inspired, out of air. It is easy to see why, not long after Runco and Jaeger’s (2012) establishment of a standard definition, that in a comprehensive overview of current neuroscientific approaches to the study of creativity, cognitive psychologists Vartanian et al. (2013) concluded that creativity is “the generation of novel and useful products within a specific context” (p. xii).

In response, creativity researchers Onarheim and Friis-Olivarius (2013) deferred to an earlier but more neurologically apt description of creativity as “the forming of associative elements into new combinations which either meet specified requirements or are in some way useful. The more mutually remote the elements of the new combination, the more creative the process or solution” (Mednick, 1962, p. 221, as cited in Onarheim & Friis-Olivarius, 2013). Here, it is *remoteness*¹⁴ that helps to elevate creativity. A variation on this definition continues to be supported by Beaty et al. (2016, 2022), whose prolific research into the neuroscience of creativity foregrounds remoteness in the cognitive processes that satisfy the criteria of novelty or originality, and purposeful or useful (see also Yagolkovski & Kharkuin, 2015).

In the context of my diffractive analysis, I apply both *novel* and *purposeful* as summary definitions of creativity. With diffractive movements and outliers that surface as glow moments, I also incorporate “remoteness” into my theorizing of creativity. Moreover, as set out in Chapter 1, I adopt the understanding that the neurobiological interplay between brain networks determines

¹⁴ For more on the definition of creativity, see Kaufman (2019); Plucker et al. (2004); and Simonton (2012), among others.

creative cognition (Abraham, 2018). Exploring how to provoke this interplay through exteroceptive and interoceptive interventions connects NsC to this inquiry.

Metacognition and Memory

Returning to the generative aspects of creativity, memory serves a critical function as it relates to the initial creative idea as well as the context in which a creative action takes place. NsC research has affirmed that visual memory is extremely relevant to visual creativity whereas verbal memory is more relevant to language-based tasks, such as reflective thinking or mapping a plan of action during the ideation phase of the creative development process (Benedek & Fink, 2019; Benedek et al., 2023). Exposure to unfamiliar stimuli activates memory retrieval, shifting bundles of stored memories from long-term into working memory where novel connections, the key to creative thought, are made. These connections draw most on semantic memory, which is chiefly associated with sense-making—forming connections between a new stimulus and relevant memories. In comparison, episodic memory draws on past events to project future possibility, allowing for past accounts and future imaginings, both real and fantastic, to be constructed (Gerver et al., 2022). Episodic memory is the most relevant to both counterfactual thinking and envisioning possible outcomes related to narrative construction, both in terms of life-story memories and imagination. Either or both types may be engaged when a longstanding curiosity is activated. Reducing the cognitive distance between memory and the creative process can be achieved with priming, disruption, and domain expertise (Gerver et al., 2022).

In combination with memory, mood and affect are also associated with creative output, particularly at the insight stage. While the mood of the artist is thought to be a contributing factor during the creative process (Newton, 2013), enabling or impeding progress in the inquiry,

Bledow et al. (2012) contend that following a period of negative emotions, the transition back to positive emotions is often a catalyst for novel thinking. Further, while creative acts can occur in myriad contexts, the most impactful relate to core curiosities, as resolution triggers a reward impulse. Rafaelli et al. (2020) found that “autobiographical episodic memories pertain[ing] to highly important personal concerns or goals ... are thought to receive heightened priority and are triggered more frequently given their association with numerous other memories related to a particular theme” (p. 335). These memories are closely associated with the salience network in the brain as they recur in unfocused thinking. Specific and resonant memories may either be triggered or intentionally recalled: “A single thought is characterized by the intersecting expressions of multiple co-occurring characteristics. The memory may also be intentionally retrieved, highly imageable and detailed” (Rafaelli et al., 2020, p. 338). It follows that priming interventions facilitating access to the most resonant memories increase the potential for meaningful creative insight.

Dual-Process Creativity Models: Generative and Evaluative

Neuroscientific assessments of artistic creativity have shifted towards inquiries predicated on process rather than product. Rosen et al. (2020) connects this discourse to the definition of creativity itself, as the brain operates in different modes when creating and evaluating work: “The functional neuroanatomy of creativity depends on whether creativity is defined in terms of creative products or the mental processes that generate those products” (Rosen et al., 2020, p. 10). Within art education, addressing the process allows the necessary space for diversity of outcomes, be they products or processes.

Most creative cognition is divided along two thinking patterns: divergent and convergent. (Abraham, 2018, Cropley, 2006). Divergent thinking draws upon memory to generate a plurality

of ideas related or unrelated to a prompt via the default mode network (DMN). These thoughts or ideas are associative connections that are unfiltered, akin to a stream of consciousness or brainstorming state, engaging little executive control. By contrast, convergent thinking relies on the salience and executive functions (CEN) of the brain for sense-making: that is, to assess connections made in the DMN, establish criteria, and evaluate thoughts—eventually arriving at a decision regarding the most suitable course of action. However, these two processes are not necessarily operating independently, raising questions around the attempt to examine each type of cognition in isolation. Moreover, Mekern et al. (2019, p. 51) have posited that what might be described as “intuitive” is quite likely the composite of (interoceptive) cognitive, affective, and aesthetic influences.

Having outlined in Chapter 1 that multiple brain networks are simultaneously activated or suppressed during creativity, I now define two types of creativity that parallel convergent and divergent thinking (Rosen et al., 2020). *Type-1 creativity* is associative control, during which more unanticipated connections can be made, and is a “bottom-up” process of connecting concepts more intuitively or reactively. *Type-2 creativity*, however, involves more focused, “top-down” executive control. Neuroscientists believe that dual-process creativity, the simultaneous activation of both types, is necessary for creative tasks that require improvisation or at least in-the-moment decision-making, as in musical improvisation or more spontaneous painting practices. The brain will activate or suppress regions and networks to allow the dual processes of creativity to occur. A dual-process model is most applicable to artists (particularly musicians) within the flow phase, during which decision-making and execution are nearly simultaneous (Rosen et al., 2020).

Mastery, Improvisation and Domain-Specific Training

Domain-specific training and practice are key contributors to enhanced creative ability within a discipline such as art (Baer, 2015). In this study, artmaking expertise was present in all participants, demonstrated either by their presence in a selective programme (post-secondary fine arts and art education) or by descriptions of their artistic process through interviews and course work. Multiple studies have demonstrated that expertise, or long-term exposure to domain-specific conventions, has a role to play in facilitating creativity: work produced by expert artists or musicians will be recognized as such (see Rosen et al., 2020). Moreover, experts demonstrate much greater response or improvement when exposed to interventions involving creative practice (Rosen et. al, 2020). At an optimal level of expertise, the artist can realize more complex connections with much less intentional cognitive focus to produce an envisioned outcome.

Expertise also reduces the associative distance between memory and novelty, meaning that sense-making, or adapting to the unfamiliar, requires less effort (Gerver et al., 2022). In NsC research, improvisation involves creating and evaluating simultaneously, but expert jazz musicians, for instance, can achieve type-1 creativity, suppressing executive control more easily. In these circumstances, the musician is more capable of achieving a flow state by anticipating a sequence of chord changes: for example, selecting combinations of notes that support the “feel” of the piece (Chan Barrett & Limb, 2019; Zioga et al., 2020). In one NsC experiment, jazz guitarists improvised over a sequence of chords; the most experienced were assessed by independent experts to have created the most effective solos, while at the same time, brain scans indicated they required the least attentional control for this task (Rosen et al., 2020). This indicates that a larger array of previously established network connections is present, which experienced musicians can access more easily than the less experienced, who must use greater

focus to plan and execute the solo. A near-simultaneous process of generative and evaluative thinking applies to art education too, as capacity/expertise is engaged in visual creative work (Ellamil et al., 2012). Distinguishing between type-1, type-2, and dual processes of creativity facilitates the analysis of creative tasks in NsC research and provides useful reference points for studying pedagogies that target each type and process.

Tracing the Creative Process in Four Stages

Elements of the creative process have been described as a quasi-linear progression from problem-finding to completion of the project. Creative interventions for art education relate to the ability to offer the learner sufficient support and context to develop the necessary insight for sustaining and returning to a flow state following an intermediate “verification stage.” The nature of the flow state itself may require less intervention, for it is during this phase when the expertise and experience of the learner-creator is engaged in an assemblage-encounter of material, concept, and technique.

The four-stage model of creative process (Abraham, 2018; Lubart, 1998, 2001) is divided into phases: preparation (pre-work research), incubation (a less-active phase during which an idea develops subconsciously), illumination (the moment when insight becomes apparent), and verification (comparing the outcome to the original creative intention). For this study, further dividing the phases by adding problem-finding (in advance of preparation) and the flow state (after illumination or insight) allowed for a robust exploration of participant engagement in the creative process. Developing interventions germane to the process requires recognizing where metacognition and priming will have the greatest effect or, by contrast, detrimentally interrupt creative flow.

Insight, or inspiration, is a moment during which an individual makes new connections that have value for an inquiry, thereby engaging the salience and executive functions of the brain. These insights vary both in frequency and degree during an inquiry, but the most resonant ones often provide 1) a viable solution to the original problem, or 2) a potential reframing of the problem (Abraham, 2018). A moment of insight can be the product of focused research or a period of mind-wandering. This is when the familiar meets the unfamiliar, bringing about the (temporary) resolution of an ambiguous state and leading to a reward impulse in the brain as the problem becomes more clearly defined.

In the next chapter, I describe interventions that target these early metacognitive phases—particularly problem-finding, preparation, and illumination stages—as they are configured to activate generative processes through both exteroception (disruptive inputs) and interoception (disruptive challenging of assumptions). On a meta level, the process involves reconciling the tensions between divergent thinking (idea generation) and convergent thinking (evaluative capacity) to respond to an initial query. Through experimentation and selection at what might be called the problem-finding stage, an individual will seek to align the interest and/or challenge of a particular inquiry, arriving at the flow state. Achieving this state, regardless of outcome, also triggers the reward impulse (Tyler & Likova, 2021). During this phase, an individual can be totally absorbed in a task, operating well beyond a regular routine—another form of supranormal behaviour.

The learning achieved through play becomes another possible method transferable to a dedicated inquiry (see Russ & Doernberg, 2019; Viskontas, 2018) by activating cognitive flexibility through non-task-related priming. In a sense, play (or experimentation) is a return to the divergent thinking phase of inquiry, most useful during pauses from focused work or as a

priming activity to increase the probability of making a novel connection. Within this study, play-based interventions, such as envisioning combinations for two remotely related objects, incorporate this element and are relevant to disrupting familiar patterns of thinking or creating for an artist.

Priming and Creativity

One way to provoke or disrupt conventional patterns of cognition is priming. Priming aligns with the initial phases of the creative process and serves one of two functions: 1) to stimulate the brain for creative work, activating *désire* and introducing mindfulness, or 2) to disrupt a process that has become stalled or stagnant by introducing novel stimuli. Priming can result in an assemblage of *désire* (curiosity), the plane of immanence (preconscious awareness), and encounter (novelty) that together form insight (inspiration). Participants in this inquiry engaged in priming activities to stimulate their creative ideation, either consciously or intuitively, through task-related pre-work or disruptive task-unrelated activities: that is, content related to priming connected to a number of procedures and dispositions.

Pre-task related priming consists of activities that provoke curiosity; they range from random (unstructured) scrolling on social media sites to walking and noticing or, perhaps, experimenting with unfamiliar media and materials. The results of these priming activities lead to preconscious awareness of potential ideas, usually expressed as a vague and indeterminate tension, something intriguing but as yet unresolved. Task-related priming involves activities intended to transform an insight into an artefact. These activities activate more methodical approaches, including developing contextual image files, researching, note-making, or mind-mapping and developing a series of sketches, thumbnail images, or prototypes. Task-unrelated priming is equally important as it aligns with artistic mood or the ability to sustain the affective

disposition to create. These priming activities involve but are not limited to regulating the environmental context in which the creative work takes place, including ambient light, sound, proximity to other people, and access to materials.

To study creativity in this context, it is more relevant to investigate procedures—cognitive, metacognitive, affective, and psychomotor—that are commonly enacted within a creative endeavour. For example, exploring pre-work phases such as research, ideation, and prototype development can identify procedural consistencies (for example, documentation of process) and differences (such as consulting with colleagues during ideation), which can account for individuated creative processes in response to the interventions as well as introspection about the creator’s own procedures and processes.

Ribbon 3: Artistic Thinking in Art Education and STS

While parallel concepts within art education theory and NsC become interwoven as ribbons of thought, there remain other aspects to theorizing creativity: aspects concerned with artistic production and pedagogical shifts pertaining to dispositional thinking and the framework of this study. *Dispositions* are pre-existing associative connections that enhance or diminish cognitive processes (Ellamil et al., 2012). For example, noticing, concentration, curiosity, and imagination are dispositions associated with creativity. How these dispositions perform in multiple disciplines or across domains offers insight into potential transdisciplinary understandings on creativity and related pedagogies.

Not surprisingly, the advent of art-sci/sci-art initiatives within academia over the past decade or so (Fleerackers et al., 2022; Grushka et al., 2018; Lau et al., 2022) exemplifies creativity, in that “forcing” remote connections between domains positively disrupts and

challenges the other, leading to unanticipated collaborative methods and solutions to inquiry. In most cases, such initiatives appear informally as short-term collaborations, local or international hubs for engagement between artists and scientists (for example, Falling Walls)¹⁵ but also as formalized collaborations, codified into post-secondary courses and programs: for example, the Convergence Initiative’s Neuroscience, Art and Society course hosted at Concordia University, Queen’s University’s Cultural Studies¹⁶ and Environmental Studies¹⁷ programs, Harvard’s Mind, Brain, and Behaviour program¹⁸ and CAST at MIT.¹⁹ Art-sci/sci-art collaborations intentionally commingle approaches to inquiry, especially those with significant epistemic distance, and challenge assumptions regarding problem definition, interpretation, or communication of findings.

In a review of art-sci/sci-art alliances, Fleerackers et al. (2022) found that artist-participants experienced an intrinsic value to developing a collaborative inquiry process, one that is “process-focused rather than outcomes-focused—often in direct conflict with the results-oriented goals of the scientists they collaborate with” (p. 6). Further to this, “many creators seemed to see participation, conversation, inspiration, and self-reflection as ends in themselves” (p. 19). Within exploratory initiatives where transversal exchanges are still developing, meaningful metacognition and documentation of process can map and refine ecologies of practice for future initiatives as well as provide a forum for epistemological exchange and the cross-pollination of domains. Fleerackers et al. (2022) emphasize that “rupturing the engrained

¹⁵ <https://falling-walls.com>

¹⁶ <https://www.queensu.ca/culturalstudies/>

¹⁷ <https://www.queensu.ca/ensc/>

¹⁸ <https://mbb.harvard.edu>

¹⁹ <https://www.media.mit.edu/graduate-program/about-media-arts-sciences>

status quo of divisions across and between academia and society offers solutions spaces rather than dictates destinations” (pp. 8–9).

These spaces of exchange lead to recursive, iterative, nonlinear, and inclusive inquiry and shared interest in meaningful problem-finding and problem-solving (see Prem, 2019; Rosin et al., 2021). As an example, within the Convergence course (DART 499/63), students negotiate form and content over several months to arrive at a project for exhibition. The process of determining signifiers to connect collaborators and audiences implicates the creative process of both domains.

Within educational contexts, there have been cross-disciplinary pairings of art and science research through art-sci/sci-art, based on the belief that a productive collaboration of domain-specific perspectives is possible (see, for example, Zaelzer & Legari, 2023). As distinct discourses across fields of study, art education and science and technology studies (STS) investigate and refine the epistemological principles of their own domain as an inherent part of their practice (see Kirkkopelto, 2019; Lau et al., 2022; Law, 2017; Schnugg, 2019). The epistemology of science is not immutable: while strict positivist approaches within the scientific method have facilitated significant access to new knowledge in terms of both methods and findings, STS is revisiting the discourse around the question of “objectivity” (see Kirkkopelto, 2019). From initial curiosity to the design of the experiment, the researcher’s bias is an undeniable component of the inquiry. Conversations between domains and disciplines offer insight into how disciplines perceive or challenge each other, opening spaces for both domain-specific and potential mutual understandings about creativity. The curricular and pedagogical initiative of STEM to STEAM (see Colluci-Gray et al., 2017; Conradty & Bogner, 2018; Knochel, 2018; Leutner et al., 2017; Quigley et al., 2019) and the Convergence course (DART

499/61), for example, intentionally pair seemingly oppositional knowledge frameworks to investigate problems.

Initiatives to incorporate art-science approaches in education such as STEM to STEAM operate as problem-based learning pedagogies that engage multiple disciplines. Quigley et al.'s (2019) longitudinal study of STEAM education, however, revealed that many of the learning “problems” are actually anchored in STEM, with the arts only marginally contributing to the outcome. In one such learning inquiry, oriented around disease-carrying mosquitoes, students sought an artistic response that involved listening to/composing a song to elicit empathy for the victims (p. 160) rather than configuring a problem that developed capacity within the arts to solve it. The challenge is to develop collaborative modes in which each domain is instrumental to the inquiry. Mobilizing knowledge using the arts as an instrumental mode of communication serves a contextual learning purpose, but in this context authentic, negotiated transdisciplinary creative processes within an inquiry remain unresolved.

Research into the hybridization of arts and science through art-sci/sci-art has garnered increasing attention at a theoretical level as well. STS, which evolved out of the shift to onto-epistemology (Barad, 2007), has a developing relationship with complementary or similar arts-based approaches. It is based on the premise that all components within science are constructed and operate as enactments of multiple agencies (see Sismondo, 2018) rather than operating within a conventional subject-object binary. For example, Borgdorff et al. (2020) contend that, although art and science may have differing purposes for their inquiries, both domains have a mutual interest in “embodied knowledge,” “material engagement,” “sensory perception,” “performance and performativity,” “agency situated in material artifacts,” and an “interventionist approach” (p. 7; see also Bequette & Bequette, 2012; Sullivan, 2010).

The shared concerns of art-sci/sci-art trace the impact of research as not only intervening in but also operating as a co-constitutive component of an inquiry. Current examples are found, for instance, in studies involving the use of wearable technologies that generate or manipulate aesthetic as well as scientific output within human/more-than-human interaction (see Borgdorff et al., 2020; Forster, 2019; Gao et al., 2022; Lysen, 2019; Schindler, 2019). The Convergence program, too, integrates approaches from the disciplines of both fine art and neuroscience, embodying the STS concept of exploratory “thinking and doing” *as* research (see Rogers, 2019, p. 77).

Despite the exploratory nature of a dedicated transdisciplinary program, Borgdorff (2010) cautions that “multidisciplinary research projects like these must still be understood as collaboration between different disciplines around a particular topic, whereby the theoretical premises and working methods of the separate disciplines remains intact” (p. 53). A related example is found within Improengineering,²⁰ a graduate-level program at the École Polytechnique Fédérale de Lausanne offering engineering students a multi-credit, full-year course of improvisation, dance, drama, and performance training. In the second half of the academic year, teams of students are required to engineer, create, and *perform with* a collaboratively produced, original artefact. In each case, the disciplines have combined experimentally to gauge what might emerge from the intra-action of agents. The ongoing challenge, however, is to determine best-practice frameworks for curriculum and pedagogy as the systems have been intentionally, albeit intuitively, brought together. Except for STEM to STEAM, research on understandings of transdisciplinary pedagogies within an art-science confluence are still developing, and in the

²⁰ <https://www.epfl.ch/labs/instantlab/improengineering>

process, the discourse produces emergent insights regarding common and distinct dispositions of inquiry that can inform understandings of creativity.

One interpretation of transdisciplinarity borrows from Barry et al.'s efforts (2008; see also Born & Barry, 2010) to identify art-sci/sci-art collaborations through three ethics (or "logics") related to transdisciplinarity: "accountability, innovation, and ontology" (Barry et al., 2008, p. 20). In this model, scientific research is accountable to its arts collaborators; innovation that attracts external attention to scientific research and ontology "discusses provoking change in both the object(s) of research, and the relations between research subjects and objects" (Paterson et al., 2020, p. 4). While these ethics are more values and concepts-driven than process-driven, they offer insight into the relationality between epistemological standpoints.

Within an art-sci/sci-art iteration, interrogating the equilibrium of each ethic within a collaborative inquiry improves understanding for researchers and audiences alike and creates new ecologies of practice. The larger aim may not be to develop codified transdisciplinary practices but instead, to open flexible spaces of exchange where subjects, concepts, and methods can be explored and negotiated. When a dialogic process occurs between researchers within the same domain, the discourse may be limited to the inquiry instead of acknowledging the limits of its own disciplinary approach. Fleerackers et al. (2022) offer a counterpoint: "By contrast, science artists often express this dialogic goal in a way that invites true criticism of science, for example, using art as a way to raise awareness about scientific failures," (p. 2). Therefore, in addition to its role as a collaborator in a transdisciplinary context, the "art" in art-sci/sci-art also operates as an "independent scrutiniser" (Fleerackers et al., 2022, p. 5), offering a combination of support, alternative perspectives, and accountability. This not only provides a counterpoint to

domain-specific scientific approaches but also aligns with a typical artistic response—that is, to engage with the public in a provocative manner.

The expression of transdisciplinary art-sci/sci-art may be, in reality, a *three-way* exchange, one that incorporates domain-specific inputs. A multi-party dialogic process requires interrogating approaches and understandings of what constitutes knowledge: how is it characterized, how has it come to be known, and how has it been communicated and with what authority. Fleerackers et al. (2022) conclude that this motivation is pivotal, arguing that new scientific information should be accessible to open discourse for all to query. For this study, commonalities between domains are predicated on activating or disrupting dispositions through “play” or “priming” rather than attempting to identify correlative transdisciplinary processes.

Ribbon 4: Thinking with Theory and Propositions

Thinking-with-theory effectively extended this inquiry, generating new insights and questions when applied to the events and happenings within an assemblage (as seen in Table 2). In the following chapter, I demonstrate how participant intra-activity with interventions creates assemblages that are diffracted through art education theory. To enact this diffractive approach, two aspects should first be addressed: the first is how thinking-with-theory operates, and the second is how it subsequently informs the selection of what theory to employ.

Just as a diffractive lens may reveal affirming or contradictory assumptions and researcher responses within an inquiry, the purpose of thinking-with theory is to “trouble” a problem with questions of ontology and epistemology to consider how they function within problems (Jackson & Mazzei, 2018, p. 721). As a process-based model, theory and gathered material or media (data) meet at a threshold in the researcher’s inquiry with the purpose of

“keeping things becoming” in the formation of new “worldings” (p. 721). The focus is on the performativity of an assemblage—or put another way, what the co-constituent agents *do*.

Hellman and Lind (2017) characterized movements and effects within an assemblage as “speed and ‘intensity’ ... [concepts which] increased in the classroom when connections were made to new material” (p. 218). In practice, learning is a “relational dynamic,” predicated on “knowing what is generated through the sensuous and immediate nature of performance” (pp. 209–210). Moreover, Ruopp (2019) extends this knowledge creation to incorporate artmaking itself: “The performative act of art making while thinking with theory about/with data, generates deliberate tensions in both logical and affective modes of knowing as they reciprocally disrupt the habits of one another” (p. 3).

For the purposes of this inquiry, I have selected Haraway (2016), Deleuze (1994), and Deleuze and Guattari (1987, 2009), whose concepts offer perspectives on creativity which are read through the findings. Haraway’s (2016) concept of *tentacular thinking* holds that a melding of time and space occurs in an inquiry through disparate connections of seemingly unrelated materials. While Haraway’s concept offers a diffractive model for my study, Deleuze (1994) and Deleuze and Guattari (1987, 2009) offer further reference points on the nature of creativity through the concepts of *désire*, *encounter*, *nomadic lines of flight*, and the *plane of immanence*. These concepts replicate elements of the creative process: *désire* reflects an initial curiosity that leads to an artistic inquiry—characterized as a nomadic line of flight—moving away from the familiar (recognition) through an encounter, toward a state of uncertainty or ambiguity (plane of immanence). The ambiguity can be queried and resolved within a creative act, engaging in the process of problem-finding until there is resolution regarding the intended form, content, and

context of an inquiry. This phase of creativity is where I intend to show that interventions have a role to play.

Table 4

Entangling Thinking-With-Theory Concepts and Propositions

Propositions	Related Art Ed Theory Concepts
intensities and affinities	desire, plane of immanence
affect and sensorial	nomadic/line of flight/tentacular thinking
process and relationality	encounter

The following examples, germane to social science research in general and particularly to art education, illustrate thinking-with-theory processes in action. Walker (2015) provides a useful example related to creativity in art education in the context of a course for in-service art educators through an application of Deleuze (1994) and Deleuze and Guattari’s (1987, 2009) writings on the nature of creativity. Amid other characteristics of creativity, Deleuze’s theory affirms an engagement with the unfamiliar (or *encounter*) as creative, while an artistic pursuit of the familiar (*recognition*) is lacking in creativity. Walker maps the progress of one of her students charged with developing a personal art project. *Encounter* played out in the student’s project and was also documented in her creative journals. As the student troubles her inquiry, she chooses to shift from a personal memoir-based project to “artmaking outside the boundaries of her usual world.” Walker (2015) describes this choice as seeking an encounter “in ways that precipitate differences that perplex and intrigue us” (p. 231). This reading-through-inquiry resulted in

Walker's (2015) assertion that Deleuze and Guattari's (1987) concepts around creativity "have rich potential for pursuing creative difference in the materiality of their lives" (p. 234).

Another example of thinking-with-theory is found in Chappell et al. (2019), who examined the nature of embodied creativity within science and arts pedagogies from a new materialist perspective. Drawing upon examples of pedagogical practice from several participating countries, the inquiry enacted six iterations of material diffractive analysis. By combining and recombining the data into assemblages, the researchers sought emergent intra-actions that resonated or "glowed" for them (p. 302). At each stage, "insights from theory and data were read through one another, enmeshing data, theory, questions, and insights together *creatively* to gain insights and prompt new questions" (p. 305, emphasis mine), distinguishing themselves from other intra-actions. In short, "diffractive analysis focuses on the juxtaposition of difference and how it makes a difference" (p. 302), and by thinking-with-theory it is possible to deepen the inquiry by juxtaposing art education and the NsC research.

From these two examples, the process or enactment of an inquiry is nonlinear, mutable, and focuses on the intra-actions of researcher, theory, and the encounter(s). Whereas Walker's (2015) reading-with theory queried the role of creativity in art education, resulting in renewed interest in developing related pedagogies, Chappell et al. (2019) used multiple diffracted assemblages as a means of extending and deepening an inquiry, underscoring the co-constitutive dispositions of the material-discursive phenomena of art and science pedagogies. However, despite the growing success of these processes for the researchers who employed them, their nonhuman ideological origins also require consideration of how ethics and values are entangled into assemblages.

In art education, research facilitates the troubling of ethical problems as they encompass and foster creative interpretations and imaginative expression, diffraction and disruption, and affect and imagination. Given the placement of the researcher as embedded and embodied within the research, returning to a value-driven curiosity invites contemplation of their ethical imperative. Rather than separated by a dualistic power dynamic, relationships among human and nonhuman entities are described, perhaps cheekily, by Haraway (2016) as “humous” or interdependent, and she employs the metaphor of “tentacular thinking” to explain how connections, however remote, can be made among entities. Other diffractive forces, particularly the technologies used to disseminate research in nearly real-time, also have an impact on the nature of inquiry (Grusin, 2016, pp. xiv–xv).

Acknowledging a multiplicity of voices and valuing human, nonhuman, and more-than-human *becoming* aligns with the material-discursive nature of posthuman properties, activating what Barad (2010) invokes as “response-ability,” meaning the epistemological and ethical capacity to respond. Rosiek (2016) adroitly identifies the meeting point of ontology, epistemology, and ethics, explaining that “every inquiry is organized not just by a conception of present conditions, but also by a conception of futurity—how things might and should be” (p. xxvi). With the posthuman turn, the relationality of multiple agencies in the studio—the student-artist, environment, material, media, curricula and pedagogy, the instructor, art education—even creativity itself may be examined through multiple perspectives.

To capture the performativity of these perspectives, each of the propositions in this inquiry provides a threshold for the intra-activity of exteroceptive and interoceptive processes as well as a related stage of the creative process. The first concept of each propositional pair relates

to internal values and dispositions, whereas the second concerns external influences on the creative process.

Intensities and affinities reflect curiosity and wonder, anchored in one's personal narrative. Intensities (what we value internally) and affinities (what we are drawn to outside of ourselves) align with the concepts of *désire* and the plane of immanence. During the preconscious phase, *désire* is the projection of curiosity over the plane of immanence, where possible resonant connections may be made. Where resonance is found, the yearning to translate possibility into reality is activated.

Affect and sensorial dispositions propel creative ideation into action by imagining possible solutions to an inquiry via divergent thinking. Affect (the impetus to create) combines with the sensorial (interactivity with the agency of materiality and technique) through the concept of nomadic, tentacular thinking that combines memories with meaning-making, including expertise.

Process relationality encompasses the two previous propositions, as process (the generative enactment of an inquiry) and relationality (the evaluative component of creative progress) combine to establish and sustain flow state. Decisions around prototype and materials are finalized for the artist/art-scientist, at least for this iteration of the inquiry. The proposition of process and relationality is recursive, meaning that the progress of an inquiry may require returning to recast the initial encounter (insight or inspiration).

Connecting art theory and the related philosophy underpinning this study to findings within NsC forms the basis of transdisciplinary communication (or translanguaging) and, through the propositions, the formation of pedagogies that may serve to mobilize emergent understandings. The first two diffractions are discussed in the next chapter, forming the

interventions. Diffraction 1, incorporating art theory concepts with NsC insights, arrived at the pedagogies that could be explored with the participants. Diffraction 2 presents the outcomes of participant encounters with the interventions. These diffractions are described in Chapter 3 to illustrate how, in Chapter 4, the content for analysis in Diffraction 3 (propositions) and Diffraction 4 (research questions) are produced. Each diffraction, therefore, informs the subsequent ones.

Chapter 3: Methodological Dispositions

The methodology of this inquiry is oriented around a series of diffractions with the intention of uncovering 1) insights into the nature of artistic creativity and the creative process, 2) its performance(s) within a practice-based, educational setting, 3) the design of interventions predicated on developing metacognition of the creative process through priming, and 4) the intra-action of creative processes involved within an art-science context.

This chapter describes the methods of diffraction and provides a rationale for the interventions activated within a hybrid in-person and remote classroom context, using qualitative methods to gather and diffract participant content. As the foundation of the study's design, a diffractive methodology supports the use of a propositional approach. Diffracting art education propositions through NsC illuminates their performance in the creative process, while the interventions allow for the lived experience of participants engaging with the concepts.

Description of Sample

There were 18 participants in the study, including myself as a researcher. All class members (from a combined total of 32) were invited to participate at the conclusion of each course once grades were approved. A letter of invitation (see Appendix A and B) describing the research inquiry and participant requirements was distributed electronically in May 2021 using the class list, after which interested participants provided their informed consent (see Appendix C). Ethics approval (see Appendix H) for this study was granted by the Research Ethics Office at Concordia University.

Specifically, elective participation comprised 11 pre-service artist/teachers enrolled in ARTE 432, an undergraduate community-based art education course at Concordia University, along with six students from the hybrid art-science Convergence course (DART 499/631). This collaborative course hosted at Concordia brings together graduate students in neuroscience from McGill University with undergraduates in Fine Arts from Concordia in a two-way engagement framework of learning. Of these six students, three were graduate students in the living sciences (Genetics, Pharmacology/Cognitive Sciences and Neuroscience) and three were undergraduates in Design or Intermedia Arts in their third or fourth year of study.

I chose to include this smaller sample from the DART course for two reasons. First, all participants maintain a form of artistic practice, independent of studies. Some were trained previously in fine arts before moving into the sciences. Others use applied art and design training in their professional practices outside of school. Taken as a composite, their skills range across a broad spectrum of performative and material practices in visual arts, digital arts, woodcraft, wearable art, dance, sonic art, and poetry. A second reason is that students who enroll in the Convergence (DART) course are curious about working transdisciplinarily, which is to say that their interest in moving beyond the defined boundaries of one discipline (art or science) to investigate and communicate concepts through the other is evidenced throughout the program (Zaelzer, 2020). This willingness to collaborate and experiment with visual language is fundamental to artistic practice and to art-sci/sci-art in general (Paterson et al., 2020).

To distinguish between participants from different domains, a demographic profile is provided as Appendix D, listing each participant's specific area of study along with their primary artistic pursuits.

Content Gathering

The study was conducted over two months (May to June 2021), during which time I collected data based on the work of the academic year. Content gathering from participants was centred around primary activities that investigated creative experiences and event-encounters across the sites of ARTE 432 and DART 499/631 (Convergence). As the sole instructor of ARTE 432, I included the interventions as course activities and wove them through the DART course in consultation with co-instructors. In both cases, prospective participants were unaware of the study until the end of the course. To interrogate responses to their own creative process on an individual level, conventional qualitative methods for gathering content were used “so that the personal experiences of the participants [could] be included in the research” (Creswell & Creswell, 2018, p. 228). Hence, diffractive content was gathered from three principal sources: semi-structured interviews; visual journal entries including the artworks, reflections, and artist statements of student participants; and my own teaching observations accumulated through the interventions. Most of the content for analysis addressed the first two research questions. However, given the low number of neuroscience students in the DART program, and the general consistency of responses to the interventions and interviews, a more robust analysis was achieved by combining the two groups into one content set.

One-on-one interviews lasting 90 minutes were conducted at both sites, documented through audio and visual recordings. I selected the “descriptive/interpretive” type of semi-structured interview (McIntosh & Morse, 2015) as it probes the experience of the participant within a specific domain and situates them as “knower.” This type of interview is suitable when there is limited knowledge of a topic and “subjective knowledge is critical to its expansion”

(McIntosh & Morse, 2015, p. 4). Further, interviews of this type rely on a metacognition of practice to expand understanding of participant experience as creators and creative collaborators.

Samples of documentation from five interventions (see Appendix E) held over the academic year included student art from 85 visual journal/digital renderings and/or artist statements and reflections. Content from participant visual journals (see Pavlou, 2021; Scott-Shields, 2016) were selected for investigation and diffraction because they provided artwork and reflections on interventions closer in proximity to the encounter than the interviews conducted after the completion of each course. Excerpts for this study were selected as illustrative of the interventions in action and their pertinence to the first research question.

Additionally, my own observations were chronicled through researcher field notes and pre-existing recordings of events from the Convergence website. My anecdotal observations were documented during the course (see Strom & Fagermoen, 2012) which permitted (close to) real-time reflection and critique of the interventions. When combined with the interview data, my perceptions and assumptions could be affirmed or rejected.

Participant content was then diffracted multiple times, with each configuration reassembled and read-through the seminal components of the previous ones. For example, the first diffraction reveals that domain-specific expertise is an underlying aspect of creativity. Both anticipated and outlying insights were highlighted using Atlas.ti software. Participant content resulted in 102 keyword concepts related to the propositions, including specificity around process, materials, and metacognitive perceptions of creativity. To foreground a constitutive rather than a reductive rendering, each diffraction produces the positive agential cuts which query the propositions that are performed either intentionally or intuitively by all participants, including myself.

Site 1. Eleven post-secondary students in an undergraduate art education course on community-based art (ARTE 432 Theory and Practice) shared written (via artist statements and visual journaling reflexive narratives), visual (via artworks and visual journal or digital sketches), and spoken responses (via 90-minute one-on-one semi-structured interviews) to course-based exercises and activities configured to foreground priming and aesthetic literacy. For example, students documented long-term creative problems they held, incorporating related but remote priming images as a means of exploring them. In another example, students used environmental priming techniques to set a mood or atmosphere for creative tasks.

Most art education students practice some form of art in a personal or professional capacity outside of the classroom. At this site, all students co-identified as both artists *and* art educators, identities which would lend authenticity and insight into their artistic processes.

Site 2. Six students from the Convergence: Neuroscience, Art and Society course (DART 499/631) supplied written (via artist statements and reflexive narratives) and visual (digital and material) coursework. They also participated in follow-up 90-minute one-on-one semi structured discussion interviews conducted online with the researcher and recorded audio visually. Activities similar to those of Site 1 were examined and implemented as part of the curriculum. Of interest, all but one student at this site also co-identified as artist *and* scientist.

Self as Site. In keeping with the diffractive approach of acknowledging the researcher as a co-constitutive part of the inquiry's intra-action, I documented my own responses and emergent questions throughout the development of curricular activities, their implementation, and their inherent interospective stages. I preserved these by keeping a teaching journal and through course notes, task descriptions, screen captures, reflective diagrammatic maps, and audiovisual recordings. By applying aesthetic literacy and priming principles to my own practice, I have

been able to offer relevant data to the diffractive process. Finally, as mapping assemblages is in part a creative act, tracing and documenting that process as a recursive and iterative component of diffractive analysis simultaneously enacts and analyzes aesthetic literacy and priming dispositions.

Creative Interventions

Activities intending to develop metacognition and/or stimulate creative connections such as generative creative tasks or appreciation of a natural or curated environment were primarily oriented around two concepts: priming and disruption. Having prior teaching experience with each course outline enabled me to plan and design interventions that would complement the existing syllabus and permit activities to flow naturally in and between course topics. In all, five activities were introduced as interventions in both sites as a way to focus student attention on interoceptive processes (mindfulness) and exteroceptive processes (priming).

Table 5

Entangling Interoceptive and Exteroceptive Processes in Interventions

Interventions: Interoception and Exteroception	
Interoception	mindfulness metaphor counterfactual thinking aesthetic literacy (alignment)
Exteroception	priming defamiliarization metaphor aesthetic literacy (attunement)

Diffraction approaches are applied to bring meaning to assemblages of data and locate the glow moments entangled within and through the participant experiences with these interventions.

In summary, these interventions asked students to:

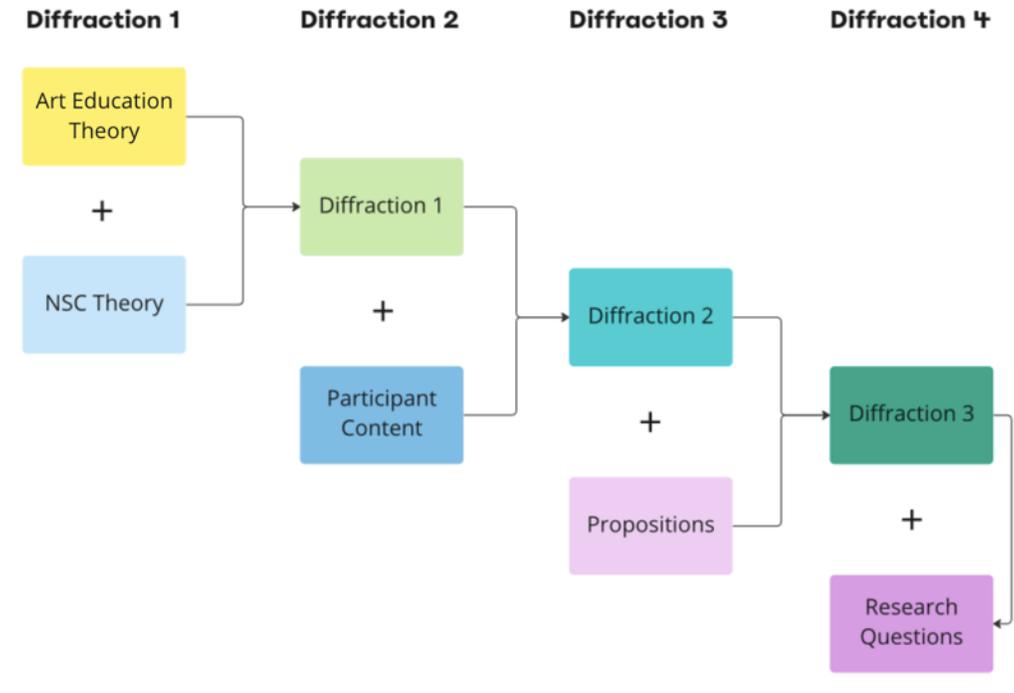
- write reflexively and compile an image file of both task-related and task-remote content (i.e., intriguing for the student, but not directly related to the task or problem)
- virtually (due to Covid protocols) immerse themselves in a curated aesthetic space such as a museum, guided by disruptive priming materials
- curate their own ideal creative space using task-related and non-task related content
- communicate a complex idea through metaphor (language-based and non-language based artistic expression) and,
- assess alternatives as a refocusing strategy with counterfactual thinking, activating memory, salience, and adaptive behaviour.

Diffraction Method

An inquiry predicated on diffraction gathers insights by performing “agential cuts” that uncover the products of difference—in this case, the performance of creativity within and across domains, “a cut that is itself cross-cut” (Barad, 2013, p. 29) or a “cutting-together-apart” (Thiele, 2016, para.10). I began my inquiry with the following four assemblages, diffracting emergent questions and concepts across them, and in so doing, created new assemblages.

Figure 5

Diagram Illustrating Four Diffractive Assemblages



Note. While the diffractive process of interference is nonlinear, messy, and iterative, this rendering is designed as a static interpretation using convergences of colour to represent transformative combinations. The overlappings and movement of diffraction are conveyed more accurately using a metaphor of waves in Figures 6 and 29.

Diffraction 1. As a methodology, diffraction is a recursive process of reading theory with practice. This first diffraction operates at a conceptual level, co-mingling Deleuze (1994), Deleuze and Parnet (2007), and Deleuze and Guattari's (1987) concepts of *désire*, encounter, nomadic/rhizomatic movement, and plane of immanence with Haraway's (2016) concept of tentacular thinking, through related NsC research concepts about creative cognition to produce the parallel and congruent concepts queried in the interventions. The data emerging from this diffraction engage concepts that serve the propositions, as they speculate on the relationships

between generative and evaluative thinking. For example, nomadic/tentacular thinking is affirmed by notions of divergent thinking and the dual-process theories of creativity, in which there is a tension between generating multiple and often far-reaching connections and the thoughts that produce resonant ideation. Out of that diffraction and supported by NsC research (Gerver et al., 2022), memory is seen as essential in creativity. For that reason, participant content related to memory stood out in future diffractions.

Diffraction 2. The results from the first diffraction inspired the interventions, which are described in detail later in this chapter. The intra-action between the participants and these interventions produced visual artefacts and visual journal content, which were diffracted through self-as-site field notes.

Diffraction 3. Insights from the second diffraction were combined with interview transcripts and recursively diffracted through the propositions of intensities/affinities, affect/sensorial, and then process-relationality to unfold a more robust depiction of the creative process.

Diffraction 4. Insights and questions emerging from the third diffraction are next diffracted through the main research questions to assess 1) the efficacy and positioning of interventions predicated on creativity, 2) the role of priming and metacognition as essential components of creativity in art education, and 3) the potential of collaborative cross-domain contexts to reveal possible transdisciplinary processes or dispositions.

Despite the pre-existing propositions and interventions, a more flexible coding system was employed at first in order for patterns and outliers to emerge organically, thereby augmenting the probability for more robust configurations of insights to diffract. All documentation was initially examined with open coding (Saldaña, 2016, p. 115). Even within

semi-structured interviews, there was sufficient congruence between the questions and their sequencing to assign codes for particular questions, such as those related to creative procedures and processes, as well as questions regarding a particular intervention (as in Activity 3—configuring an ideal workspace for creative work). The open codes were then grouped by relevance (i.e., related to the pre-work phase of creativity) and then diffracted through each of the parallel concepts derived from the first diffraction. Each of the coding groups from the second diffraction was then diffracted through the propositions.

Diffractive Analysis

Although the participant content is gathered using qualitative methods, the process of analysis is diffractive, as Lenz Taguchi (2012) outlines:

The event of analysis thus becomes a transcorporeal engagement in which the researcher is attentive to bodymind faculties that register the flows of smell and the intensities of touch, level, temperature, pressure, tension, and force in the interconnections that emerge in the engagement. We try to register how data interferes with the sensibilities of our bodyminds, and what this brings to the event of reading the data. (p. 272)

In this more holistic engagement with the data, the ontologies of the researcher and the inquiry are not oriented around subject/object binaries but are both constituted within the assemblage or entanglement. It was important not to miss out on emergent processes and values stemming from the intra-action. Another level of mindfulness is required to balance domain-enforced “order and radical intensity” and “the dangers of leaning too heavily on one side of the assemblage” (Gray et al., 2021, p. 211). This accountability is congruent with the “ethics” theory of transdisciplinarity (Born & Barry, 2010) and the positive, disruptive qualities of encounter and difference.

Data analysis was conducted using Atlas.ti, a platform with the ability to perform complex searches of both coded qualitative and visual data, enabling the researcher unlimited options for sorting and combining data with concepts. Each interview transcript was queried for anecdotes and comments that resonated with the concepts emerging from the first diffraction. In that sense, the diffractive reading of theory with practice would be accomplished. Subsequent phases of data analysis were driven by the insights and outliers of the primary phase.

Glow Moments

A materialist diffractive analysis is iterative, combining and recombining participant content, interview transcripts, project documentation, journal entries, artworks, and student presentations, along with researcher observations, to produce glow moments (MacLure, 2013). These moments represent illumination(s) or connection(s) reflected in a data set that particularly resonate with one or more of the propositions. Out of the data, moments that glow are subsequently examined together to allow for new entanglements and assemblages to emerge, offering further insight into, or possibly disrupting the propositions. However, part of this process also queries specific data that appear as outliers or that stand in juxtaposition to a proposition, for the richness and complexity of an assemblage or entanglement can be more authentically explored by identifying and interrogating the patterns of interference as well as those that resonate.

Figure 6

Diffraction Movement



Photo Credit: M. Roy

Note. Seen as iterative movements that produce patterns of interference, the assemblages are diffracted through one another, with interventions emerging from the first diffraction in the foreground. Participant content from the interventions leads to the formation of “glow moments.” Content that “glows” is then diffracted through propositions, leading to more glow moments, which are then diffracted through the research questions.

Diffraction 1: Art Education Theory + NsC

To investigate the meeting points between NsC and art education theory, I queried groups of participants regularly engaged in both individual and collaborative tasks requiring creativity. Observations and descriptions of their process allow participants to display and reveal their relationality to their own creative thoughts, feelings, and actions. Although diffraction can be

applied to a variety of data sources, I elected to use qualitative content that allows for rich descriptions of complex human processes—in this case, creativity. Given the learning contexts in which the procedures (interventions) are implicated and that participants were asked to reflect on and communicate their process thinking, this allows more latitude for individual differences, leading to a more detailed exploration of outliers. Exploring specific moments of the creative process with smaller interventions and aiming to develop greater metacognition of the creative development process among participants permit an expanded understanding of creativity in action and the ability to trace how NsC research insights might transfer to the educational domain.

Having identified some parallel structures that exist between NsC and art education theory, diffracting each through the other produced some conceptual guideposts intended for the development of interventions. These interventions target procedures, while the journal and interview content are configured to query process.

Table 6

Entangling Art Education Theory and NsC Concepts with Existing Creative Theory

Entangling Art Education Theory Concepts and NsC	
Related Art Ed Theory Concepts	Related NsC concepts
desire, plane of immanence	long-term memory (curiosity), priming, rarity
nomadic/tentacular thinking	mind wandering, hypofrontality, experimentation
encounter	insight (inspiration)

The associative form of creativity in NsC resembles Deleuze and Guattari's (1987) plane of immanence, a pre-conscious awareness of potential for a novel connection to occur, enhancing the capacity to observe and notice. It also parallels the default mode network of the brain in that it is a limitless source of ideation, yet most randomly generated thoughts are not fruitful (Goldberg, 2018). For that reason, the performance of the salience network can discern whether ideas may be germane to an inquiry.

Interventions within the study challenged participants to explore and compare both familiar and unfamiliar priming materials to identify and disrupt their preferred patterns and modes of creativity. To situate confluences, I begin with the concept of *désire*. As defined by Deleuze and Guattari (1987), *désire* denotes the impetus or predisposition to create, having points of connection to a combination of visual memory, long term memory (curiosity), semantic memory (sense-making), and episodic memory (imagination). While each type of memory may contribute to differing degrees in artmaking, they form the foundation for the ideas that motivate expression. Developing pedagogies or practices which activate memory, subliminally or metacognitively, are therefore of interest. One example seen in the interventions is a self-curated image set, which included both task related and non-task related content. Non-task related content is selected to offer intriguing images that can stimulate novel creative connections.

Désire is also inherently connected to the concept of encounter or *difference*. Amid other characteristics of creativity, Deleuze's theory affirms an engagement with the unfamiliar (or an encounter) as creative, while an artistic pursuit of the familiar (*recognition*) is lacking in creativity. Resolving or incorporating the unfamiliar connects with the reward impulse in the brain, akin to solving a puzzle. Studies in creativity note that remote, yet still relevant,

connections produce the most resonant creative ideas (Yagolkovskiy & Kharkurin, 2016). To simulate this connection, participants were guided to identify and document random objects they encountered in a curated space to disrupt their own conventional observation pattern and aesthetic preference.

As defined by Haraway (2016), string theory and *tentacular* thinking provide metaphors for connections to be made across time and location by means of episodic and long-term memory. This form of thinking approximates Deleuze and Guattari's (1987) *rhizomatic* or *nomadic* thinking. NsC has affirmed that hypofrontality, a mind-wandering state, can exist when one is not directly focused on a problem (Goldberg, 2018). This state relaxes CEN (executive) control and allows for more associative connections to be formulated. Metacognition of the advantage of hypofrontality also connects to the value of delaying closure (Walker, 2004). Metacognitive awareness of hypofrontality came through an exercise on counterfactual thinking, which may activate subliminally during a mind-wandering phase rather than intentionally when delaying closure. Nevertheless, attempts to influence hypofrontality through interventions may prove counterintuitive as they reactivate executive cognition, the opposite of mind wandering.

Glow Moment from Diffraction 1

What appears to be a significant glow moment within this first diffraction is the influence of expertise. For a participant group that holds substantial experience in creative contexts, including pre-existing dispositions such as curiosity and an intuitive ability to visualize concepts or ideas, the assemblages in subsequent diffractions emerge within accounts of creative work, some metacognitively and some implicit in the anecdotal content. Expertise within a domain reduces the distance between memory and novelty; there is an inherent disposition to

identify and explore avenues of creative exploration. For artists and artist-scientists, creativity is in part determined by recognizable alignments or transgressions of a pre-existing epistemological framework. Expertise pre-supposes sufficient domain-specific capacity to conduct an inquiry. It may also extend to capacity within collaborative contexts, which speaks to the capacity to know how to make the best use of domain-specific methodologies.

Diffraction 2: From Propositions to Interventions

Along with the diffraction of NsC through the theories of Haraway (2016) and Deleuze and Guattari (1987, 2009), the propositions of intensities/affinities, affect/sensorial, and process and relationality are engaged around the following modes of inquiry.

For the proposition of **intensities/affinities**, the concept of priming (Minas & Dennis, 2019) was borrowed from current research into NsC and explored through a creative arts-based context as an important spark in the artistic process. Appropriation of processes from one discipline to examine concepts in another is a hallmark of transdisciplinarity (Chappell et al., 2019; Marshall, 2014a, 2014b). Assemblages of interoceptive processes were diffracted, including components of Gallagher's (2015) concept of aesthetic literacy such as alignment and attunement, using artist statements, visual journal entries, and researcher observations of both pre-service teachers and students of the Convergence program.

For the proposition of **affect/sensorial**, participants mapped their learning trajectories through a number of event-encounters (Miles & Libersat, 2016), activating both language-based and image-based/abstract depictions to locate those processes describing the pathways to creative impetus for artists. In my study, cartography (Hernández-Hernández et al., 2018; Rousell, 2021; Rousell & Fell, 2018) took a variety of forms in ARTE 432 through planning a student-run art

exhibition and through mindfulness strategies within a museum context,²¹ to reveal situated creativity and embodied engagement (see Krucoff, 2019; La Jevic & Springgay, 2008). Within the Convergence program (DART 499/631), propositional thinking assisted in the (re)mapping of relationships between science and art. Similar priming activities extending from existing course strategies and based on intentional defamiliarization (Springgay & Truman, 2018a) were designed to disrupt pre-determined approaches to aesthetic encounters (akin to rarity priming in NsC). Assemblages of reflections on creative processes during artwork development and from artist statements during presentation were diffracted, including the researcher's own responses to presented work—for example, observations and visual journal entries from a museum visit or from culminating student presentations.

For the propositions of **process and relationality**, the concept of *troubling* (Haraway, 2016) disrupts assumptions about the creative process and relationships to materiality through recursive, iterative, collaborative practices. The conception, process, production of, and reflection on creative work serve as catalysts for this exploration. I examined visual journal entries pertaining to assignments: in particular, creative process reflections, artist statements, images, and observations of activities within both the community art education course and the Convergence course. Assemblages of references were diffracted with metacognition of the creative process, and responses to priming activities were engaged. Such activities included artist statements, visual journal entries, researcher observations, class discussion, and interviews.

²¹ Owing to restrictions the COVID-19 pandemic placed on physical distancing and in-person attendance, students could elect to virtually “step inside” museums through an online Google Arts & Culture virtual reality touring link: <https://artsandculture.google.com/project/virtual-tours>

Descriptions of the interventions applied in this diffraction, including participant content emerging from the assemblages, are detailed below. Table 7 offers a guide to the relationality between the interventions and the propositions.

Table 7

Interventions Diffracted Through Propositions

Interventions/Activities by Proposition			
Interventions	Intensities/ Affinities	Affect/ Sensorial	Process/ Relationality
Activity 1: The Image File as a Self-curated Priming Tool	X	X	X
Activity 2: Defamiliarization with a Curated Space – Priming for Mindfulness	X	X	
Activity 3: Curation of a Creative Space: Environmental Priming and Aesthetic Literacy	X	X	X
Activity 4: Communicating a Complex Idea Through Artistic Expression		X	X
Activity 5: Assessing Alternatives Using Counterfactual Thinking	X		X

Activity 1: The Image File as a Self-Curated Priming Tool

The first task was related to supraliminal priming and rarity. Research into creativity has shown a correlation between the use of priming and the ability to develop a higher frequency of responses and more diverse responses to a prompt (Minas & Dennis, 2019). An essential question guided my thinking in this part of the inquiry: *How does rarity in the selection of task-related and non-task related priming materials influence the creative process?* For artists, compiling an image file can provoke thinking about form, content, and context (culture). This can be done by arraying, manipulating, and contemplating images, incorporating them into a workspace as a stimulus or motivational tool, or by offering a visual break or reset. In this activity, students were asked to do the following:

1. Create an image file of 10 artefacts that are directly related to preparing for a visual assignment or task.
2. Select 10 artifacts that are compelling but unrelated to the task, challenging themselves to seek out images they might otherwise overlook (rarity).

In ARTE 432, students collaborated by sharing their image files online. In DART 499/631, this took the form of a Daily Art/Daily Science sketchbook/ journaling activity. Students were asked to consider their priming task and non-task related image selection decisions through the following questions:

- Do you notice any similarities between the two image sets?
- What patterns exist within your image sets?
- Are there image choices that are easier to explain than others? How do you account for this difference?

Post-task, students reflected on the following questions in a virtual visual journal:

- Which task-related images/artifacts did you gravitate to during the process?
- In what way were they more influential?
- Which non-task related images/artifacts did you look at frequently during your creative work (for an assignment)?
- How did you respond to them?
- If you became stalled or stuck during the process, were any of the images useful in reframing your approach? If so, were they related to the task?

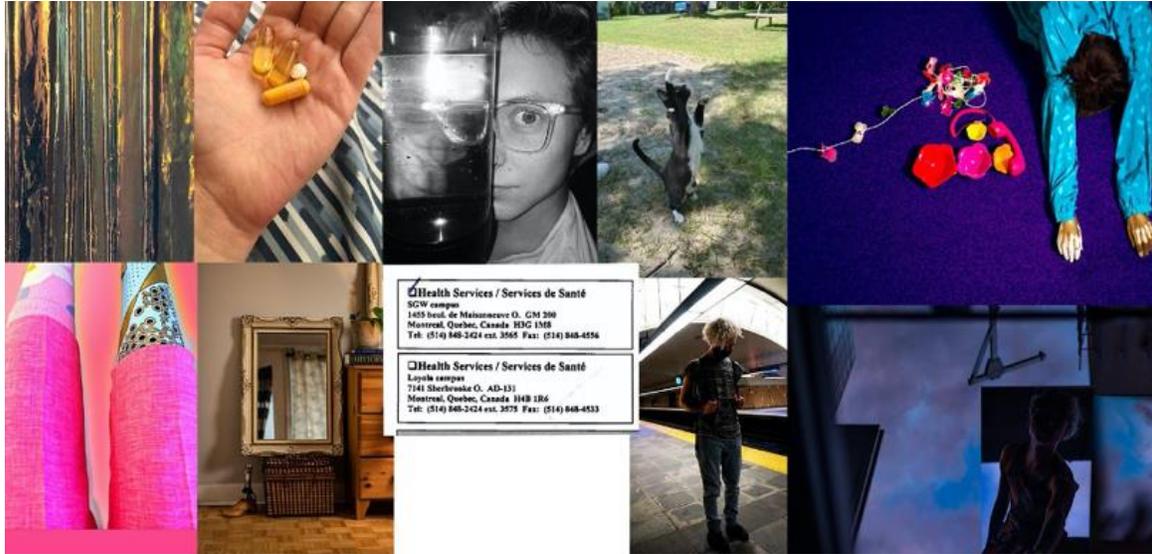
Describing the differences between the two sets she had compiled for a Daily Art, Daily Science visual journal entry, Emery wrote,

As an artist in this class, I was required to look at daily science in my life. I feel like in the 1st set of images there are a couple that obviously related to medical science ie. hand with pills and screenshot of a medical requisition. The 2 images on the far right are creative photos yet, I felt like my approach in the edits were a very logical, almost “scientific method” approach. Meaning, I hypothesized how the final images would read, experimented with Photoshop to reach the conclusion, and then had a result at the end.

(Emery DART 499/631)

Figure 7

Task-Related Images, Emery



Images courtesy of Emery, DART 499/631

Figure 8

Non-Task Related Images, Emery



Images courtesy of Emery, DART 499/631

I find the second set of images easy to explain because I didn't have to think about them in terms of working for a specific assignment—I just loved their vibe. I think they all have a sense of humour, whimsy, a good use of colour and feel rather nostalgic to me, which

are things I'm automatically drawn to. ... I also feel really nostalgic looking at the second images, like they're a romanticized version of memories I've had, whereas the first sets of photos were actually shot in my daily life. (Emery DART 499/631)

Whereas Emery's images drew on memory and associative thinking processes that caused her to feel "nostalgic" about "their vibe," Felix, a design student and self-described craftsman with acutely artisanal interests, intuitively gathered non-task related images that evoke materiality and multisensorial affect. The tactility, for example, of a spiky blue allium, the dense form and smell of bread, and the visual patterning of hexagonally woven leather convey fundamental principles of design through textures, shapes, and surfaces that served as priming images to stimulate creative thinking for him.

Figure 9

Non-Task Related Images Conveying Sensorial/Affect Through Multisensory Associations, Felix



Image courtesy of Felix, DART 499/631

In ARTE 432, students gathered task-related and non-task related images, later using them to co-create assemblages online in real time using shared image files. While sourcing task-related images aligns with most participants' procedure, finding non-task related images was more open-ended and, for some participants, a less certain process.

The arts-based practice of visual journaling as documented knowledge (Irwin et al., 2006; La Jevic & Springgay, 2008; Sinner, 2011) is a priming tool that evokes a sense of iterative movement, influencing the trajectory of making-thinking through words and images that provoke and inspire. Scott Shields (2016) describes this form of knowledge collection as a “point of reference to return to, something documenting our understanding” (p. 9). Similar to tentacular thinking (Haraway, 2016), this process produces a “convergence, overlapping and rushing of ideas... much like the ocean, constant but always changing—a cacophony of elements colliding, creating an ebb and flow of thought. ...a rhythmic pulsating motion propelling me outward” (Scott Shields, 2016, p. 2). It is a form of ideation, documentation, and introspection that reveals assemblages of interoceptive and exteroceptive influences, generating rich content for analysis in this inquiry.

Figure 10

A Composite of Task-Related Images from a Collaborative Visual Journal Assignment



Note. In Figure 10, ARTE 432 students co-constructed assemblages of metaphors for teaching in community using shared image files.

Activity 2: Defamiliarization with a Curated Space: Priming for Mindfulness

The same essential question guided my thinking for the second activity: *How does rarity in the selection of task-related and non-task related priming materials influence the creative process?* ROAM cards were designed as a game-based activity to disrupt encounters in public art settings and were inspired by an interactive mobile creative tool that uses disorientation as a part of the wandering process—provoking or altering engagement with the urban landscape and challenging spatial cognition. The mobile app intentionally reshapes user experience, subverting reliance on navigational technologies. Borrowing from Springgay and Truman’s (2018b) propositions for walking as a speculative and relational “thinking with,” I adopted similar prompts as a deterritorializing priming tool. In this activity, students were invited to visit Google’s Virtual Gallery website²² to explore a self-selected museum space virtually or in-person (where permissible), recording their observations using the ROAM cards and documenting their responses both digitally and with sketches.

This approach offered a way to bring “the practice of being *inside* a research event” [and] “to ‘begin’ in a speculative middle” (Springgay & Truman, 2018b, p. 204), de-stabilizing the conventional subjective/objective binaries of human movement through/within a space. Applied to a curated environment such as a museum space, ROAM performs as an immersive, disruptive, reflective, and metacognitive practice, evidence of the interplay between experience and sense-making.

Students were given a set of eight ROAM cards designed to defamiliarize their progress through the space. The ROAM cards contained instructions such as: *Walk quickly in the direction*

²² <https://artsandculture.google.com/project/virtual-tours>

you're facing. Look for something that's hard to identify. Stop when you find it. Sketch or photograph the object. More sample instructions are listed in Table 8:

Table 8

Examples of ROAM Card Prompts, an Intervention Designed for Priming in Activity 2

<p>Walk quickly in the direction you're facing.</p> <p>Look for something that's hard to identify.</p> <p>Stop when you find it.</p> <p>Sketch or photograph the object.</p>	<p>Take two large steps forward.</p> <p>Turn left.</p> <p>Look up.</p> <p>Sketch/photograph the object you notice first.</p>	<p>Turn around.</p> <p>Choose a number between 16 and 23.</p> <p>Walk that number of steps.</p> <p>Look for something fascinating.</p> <p>Sketch/photograph the object.</p>
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In diffractive methodologies, the unfolding of the unexpected—events within events that in turn form new encounters—re-shape the intra-actions of an inquiry. A further disruption of viewership was imposed by the pandemic owing to restrictions on physical distancing. Hence, planned in-person encounters were mostly replaced by self-selected virtual museum site visits.²³ At first, I had misgivings about the revised activity as its design would become altered by suppressing the physical possibility of an event encounter, potentially inhibiting the relationships

²³ <https://artsandculture.google.com/streetview/rijksmuseum>

that exist/surface within an environment between human and nonhuman elements. In my journal, I reckoned with the dilemma:

The virtual touring interface was challenging as I frequently had difficulty achieving the desired direction or command—sometimes I found it overshoot the mark, by-passing the artwork or zooming in too close, disorienting me. The awareness that there was such an extensive showcase of museum permanent collections was exciting: so much choice, seemingly so accessible. At the same time, the experience was off-putting—I suspect that most students will avoid virtual tours until the technical capacity improves. [Personal communication, January 2021]

Springgay and Truman (2018b), however, consider that “a speculative middle does not stop a researcher. It’s a thrust, a future provocation for thinking-making-doing ... In the speculative middle, which is not a place, but an event, (in)tensions, concerns, and gnawings continually emerge” (p. 208).

Post-task, students considered the most significant or surprising discoveries they made, particularly in the context of virtually visiting a museum space:

- What was the experience of following the ROAM cards like for you? In which other educational contexts would this activity be useful?
- How might this experience influence the way you explore (curated) spaces in the future?
- Which objects did you discover that were the most interesting?
- What other wonderings do you have after this activity?

Kassandra was inspired by the prospect of immersing herself in a museum space, even virtually:

I didn't know how much I missed visiting museums until now. It felt so refreshing to "walk" inside a gallery, discovering new artists and places that I knew nothing about, even if it was from the small screen of my smartphone. (Kassandra, ARTE 432)

Figure 11

Kassandra's ROAM card, pen & ink

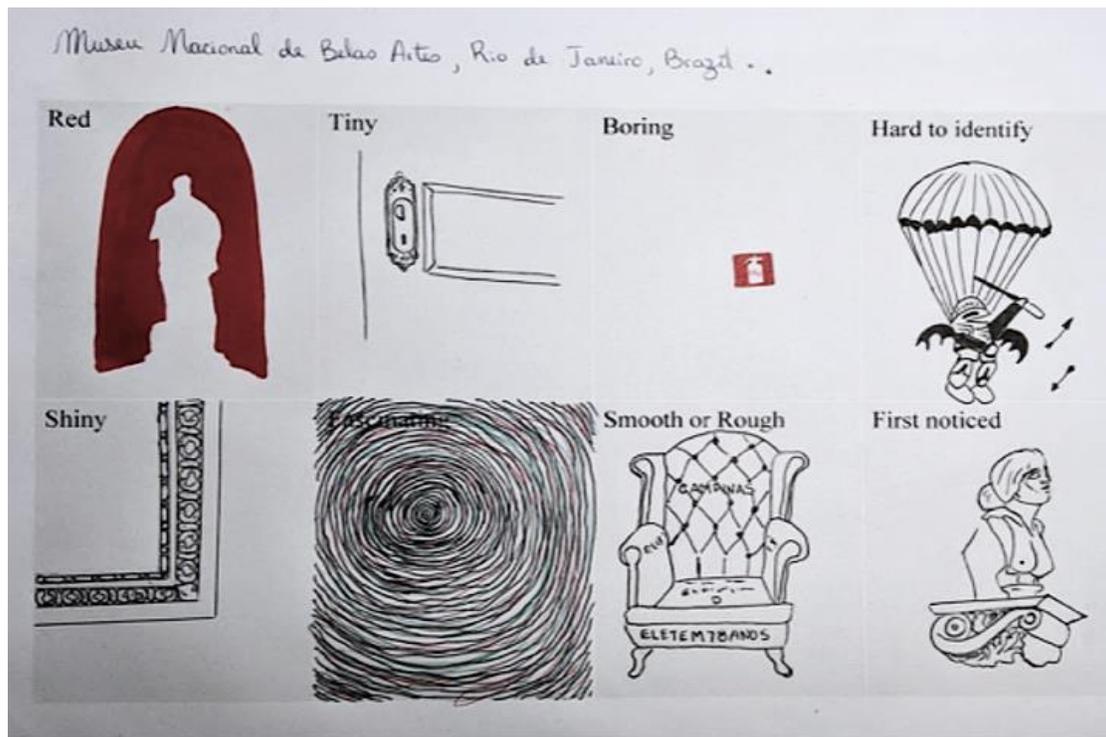


Image courtesy of Kassandra, ARTE 432

Rejecting the pandemic response to museum-going, Jane took the priming event outdoors to find artistic expression in street art, encounters that particularly resonate for her as an artist.

For the experience, I chose the Paris Tower 13. It was an abandoned building full of graffiti. It was very interesting to go there, be overwhelmed by colourful and gigantic designs, yet having to focus on a power outlet or the exit sign. Following the roam cards

was an enriching experience. It was a good way to make us observe known places (and unknown places) from different perspectives. Similar to Mindfulness, in which the workshops showed us how to find the intricate in the mundane, it made me pay more attention to overlooked aspects of the rooms. I liked it so much I went on a stroll with my boyfriend with the same cards. We wandered around our neighborhood to find something red, something boring, something shiny. (Jane, ARTE 432)

Similarly, students independently navigated ways to use the priming tool that suited their artistic interests and curiosities (desire). Whereas Amanda’s image of “something shiny” illustrates the challenge of dexterously manipulating the zoom feature in a museum virtual touring app, Coney’s rendering of “something small” provided the opportunity to paint a response, an embodied entanglement of affect, memory, and imagination captured in material detail.

Figure 12 (left)

Something Shiny, *Digital Screen Capture, Amanda*

Figure 13 (right)

Something Small, *Ink & Gouache, Coney*

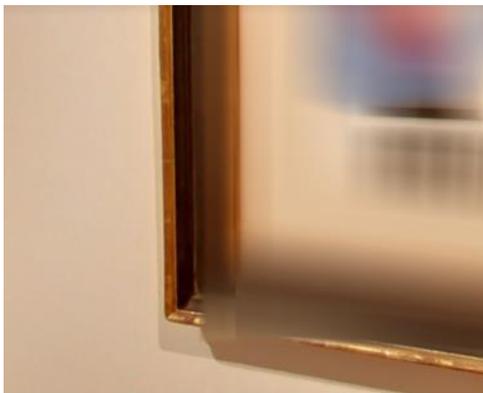


Image courtesy of Amanda, DART 499/631

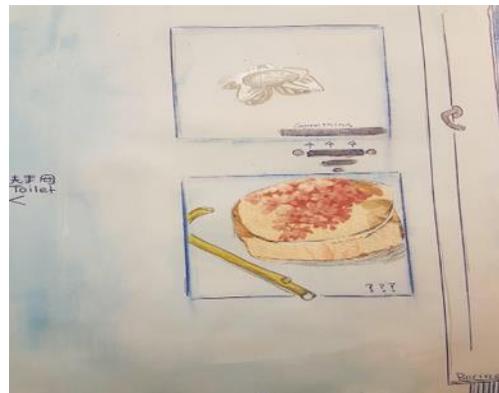


Image courtesy of Coney, ARTE 432

However, not every student was able to engage in a satisfying way with the activity. Felix, a board game designer, was confounded by the spatial limitations and challenges of the virtual museum space, and it signaled for him a flaw in the activity’s design.

Things like “walk slowly in a circle” are impossible to do in this setting. So when I’m given this instruction, what should do? If I need to interpret or modify the commands on the cards at each step, I would be editing the game on the fly? If I need to bend the instructions of the game to make it work, why follow the instruction at all? I mean, in this type of game the only rule is to follow the rules. (Felix, DART 499/631)

Figure 14

Digital Screen Capture as Documentation of Intensities and Affinities, Felix

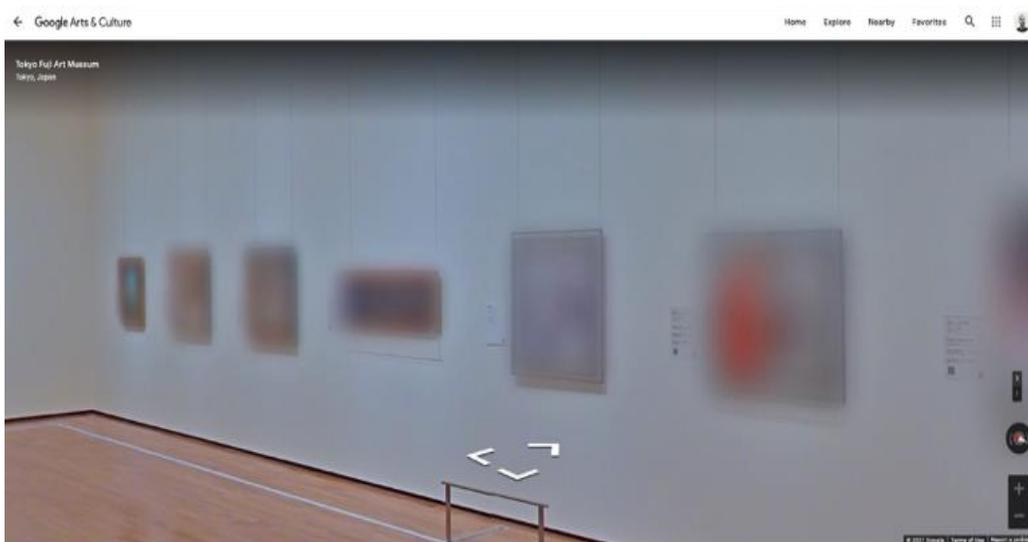


Image courtesy of Felix, DART 499/631

Note. Freedom of movement and flexibility are important features in a virtual museum tour.

Felix’s account struck a poignant note, echoing my own uncertainties about the hapticity and manoeuvrability of the cursor, or the capacity of the virtual museum site to display with sufficient clarity the mundane objects the activity is designed to provoke interest in. Further,

museum touring in the virtual domain can deprive the viewer of multimodal and multisensory opportunities for experiencing and engaging with works of art. Still, although the virtual experience was not optimal, most students were able to overcome its limitations, a challenge Emery met through experimentation:

Since the sculptures were often in the center of the room, it was easier for me to click my mouse around and take in the detail, whereas if I went too close to a painting, often it would just become one blur. I [knew] the works would have more impact if I saw them in person. I missed things like scale, texture, and the tension of works curated in a space. I even ended up doing the card activity in a salon that featured tiny, soft abstract work because I got upset knowing the pieces I resonated with would translate poorly in a screenshot. (Emery, DART 499/631)

One student, attending to the agency of the cards themselves, expressed a desire to linger in gallery spaces with specific artworks but felt compelled to move onward: *“there were times I’d see something that really intrigued me, and the cards pulled me in another direction”* (Amanda, DART 499/631). At the same time, this student acknowledged the inherent priming effect: *“the ROAM cards...encourage[d] me to look at things I either would overlook typically or engage with things differently in a way that isn’t governed by my first instincts or the things I’m already interested in”* (Amanda, DART 499/631).

Figure 15

Roam Card, Felipe



Image courtesy of Felipe, ARTE 432

Activity 3: Curation of a Creative Space: Environmental Priming and Aesthetic Literacy

Environmental priming diffractively emerged from the concepts of Activities 1 and 2. Priming activities in the third intervention focused attention on environmental (subliminal) and task-related (supraliminal) stimuli, as well as the value of disruption (rarity), including remotely related or non-related content to disrupt assumptions or unblock active creative work. Guided by the essential question—*How does priming through an awareness of environment shape creative praxis and response?*—this activity queried how students might configure a creative workspace.

Specifically, students in both the ARTE and DART courses were invited to imagine/design a workspace for creative tasks, producing both a visual depiction of the space through illustration or digital/photographic images and a brief description to serve as rationale for their key decisions and how these might enhance creativity. During the task, students were asked to consider all five senses as well as materials and artefacts, light and sound sources, furnishings, equipment, and the proximity of the imagined space to others working on creative tasks. Post-task, students responded to the following questions:

- How does this exercise reveal your beliefs about your creative process? Did anything surprise you?
- Do you feel that you may have left something out that should have been included?

In response, Felipe described a calm and comforting space designed for multisensory stimulation and interaction with others:

My ideal workspace is the equivalent of a pillow room. Not strictly speaking, but a space with comfortable chairs, big bean bags and [a] fluffy carpet upon which you can walk barefoot. Ideally, it would have huge windows, high ceilings and will be very luminous during daytime. Alternatively, during dark days or night, the dimmed lighting coming from standing lamps would settle the mood for the room. Many plants and lots of colourful artworks, or colourful walls are decorations Feng shui style. Outside there would be plants, trees, and an open field.

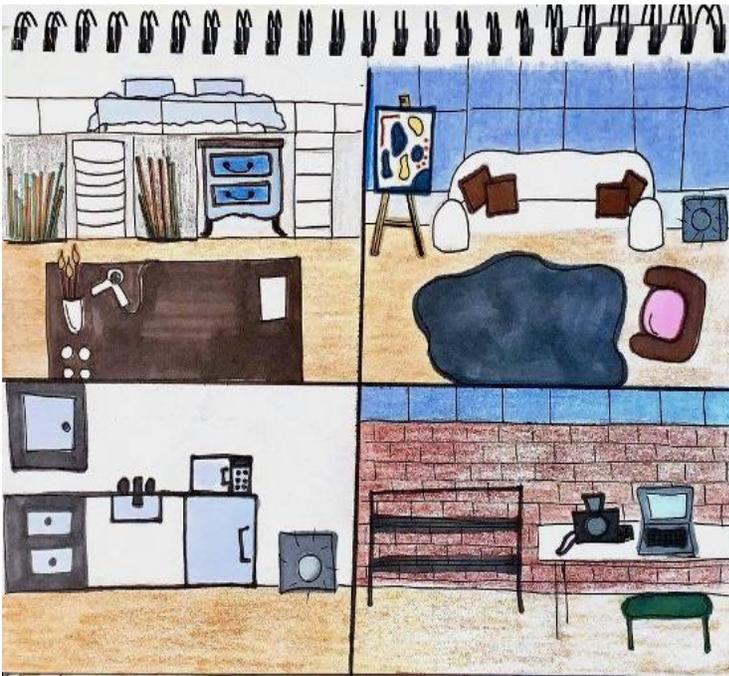
This space would be warm and cozy, and it would have a fresh floral scent that permeates from the outside to the inside. Smells of oil paint workshop would also float adrift and mix with the wood tones of the forest. Ideally, the music will be something soft and cool. Maybe lo-fi, or classical music. Or something in between. A space where

people can exchange safely without constraints. A space where people can feel at ease and can engage easily in conversations with people. (Felipe, ARTE 432)

Focusing on light and space for physical comfort as well, Eva felt the design should incorporate materials that would nurture her during the sometimes solitary process of creation:

Figure 16

Eva's Self-Curated Priming of an Environment for Creative Work



My ideal creative space would be a comfortable open studio, where I can be alone but big enough to be able to work with other artists on collaborative work. The studio would have giant windows for all day brightness, tall brick walls, a table for ceramics and drawings, paintings, drying rack, a storage space for projects and materials. It would also have another corner with a desk devoted to photography and computer work. Artwork would be hung and displayed for consistent motivation. A comfortable couch would also be needed for some downtime. Big lamps and incense and... a mini kitchen and stereo system for late night snacks and musical inspiration! (Eva, ARTE 432)

Image courtesy of Eva, ARTE 432

Jane's shared studio would claim space for a garden, for creative play, and collaboration with others.

Figure 17

Jane's Design for a Space Featuring the Importance of Collaboration in Creative Work

My workroom would be a shared space with other artists. Nothing motivates me more than other people working on their craft and passion. The common room will be open for visitors as a common and inclusive space to create artworks. There would be individual/quiet rooms for the artists... There would be a library of scraps where anyone could use others' old material and play. Music will play, coffee and tea are always available.... A community garden on the rooftop will help unwind and discuss with local gardeners. (Jane, ARTE 432)

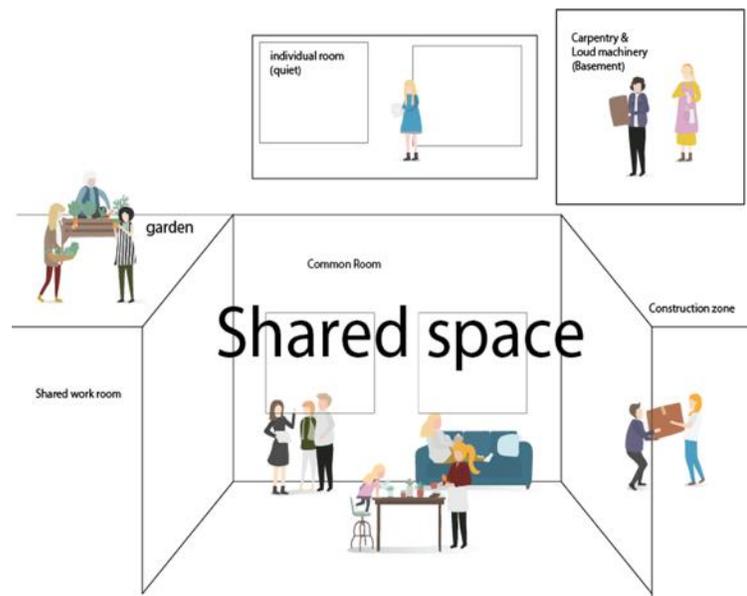


Image courtesy of Jane, ARTE 432

Amanda, a dancer and artist/scientist, used downloadable content from the Sims 4 Resource website to portray a workspace where component features would, as she described it, “enhance” her creativity. Some of these features were sensory while others were intuitively proprioceptive, having to do with the physical arrangement of things and her ability to move around and between them. Attending to these details, Amanda's metacognitive awareness of priming extends to curating the exteroceptive influences on her process:

Figure 18

Amanda Considers the Multisensory Exteroceptive Influences in the Metacognition of Creativity

Input	Description
Auditory	“Music player present for ambiance when painting/sewing and for dancing (also why the mirrors are on one wall) and thinking while pacing”
Visual	“Somewhat busy (I feel less inspired around minimalism, I like being primed by the atmosphere).” “[A] mixture of bright colours/black and white (find that striking and good for priming creativity) and mix of classy/historical and gaudy/pop art like aesthetic (combines all the movements that appeal to me and inspire me). “
Space	“Large for pacing/dancing. Lots of separate stations for painting/art, sewing, and dancing. Lots of tables that can be moved around easily (facilitate space to cut fabric, make lino prints, or move out of way to dance as needed)”
Lighting	“I prefer overhead and window light. Find it warm and easier to properly see everything I’m working on.”



Image courtesy of Amanda, DART 499/631

Defining her studio's location, Amanda continues: "*Ideally this is a room in my dream house. I would usually work alone in there but would invite other people in sometimes too for input/working together. I find I'm less inhibited/generate ideas best alone.*" (Amanda, DART 499/631)

Similarly, Kassandra considered the variety of materials she uses in her artmaking and offered that her ideal studio would be one with a space for everything in a room that is *very spacious and with many windows, as I prefer working with daylight. I would certainly have a little jungle corner where I would like to meditate and clear my thoughts or recharge my creative energy. I would love to have my dogs around as they bring peace and happiness to my life.*

I'm a multidisciplinary artist, so I would like to have different small sections for fabrics, knitting, ceramics (with a kiln), wood cutting ... painting, cyanotype set-up, multiple sculpting tools and of course a sewing machine! My workspace would always have to be very clean and organized, as I use so many different tools and materials.

(Kassandra, ARTE 432)

Felix, too, took a pragmatic approach to sorting and storing materials. In this instance, emphasis was placed on the arrangement of rolling shelves and bins as an "*archival space*" that would perform its own narrative, alongside spaces for thinking and making, where "*ideas can be tested, critiqued, evaluated, investigated, refined, recycled [and] converted.*" (Felix, DART 499/631)

Figure 19

Felix's Studio Design Focuses on Spaces Where Narratives Emerge

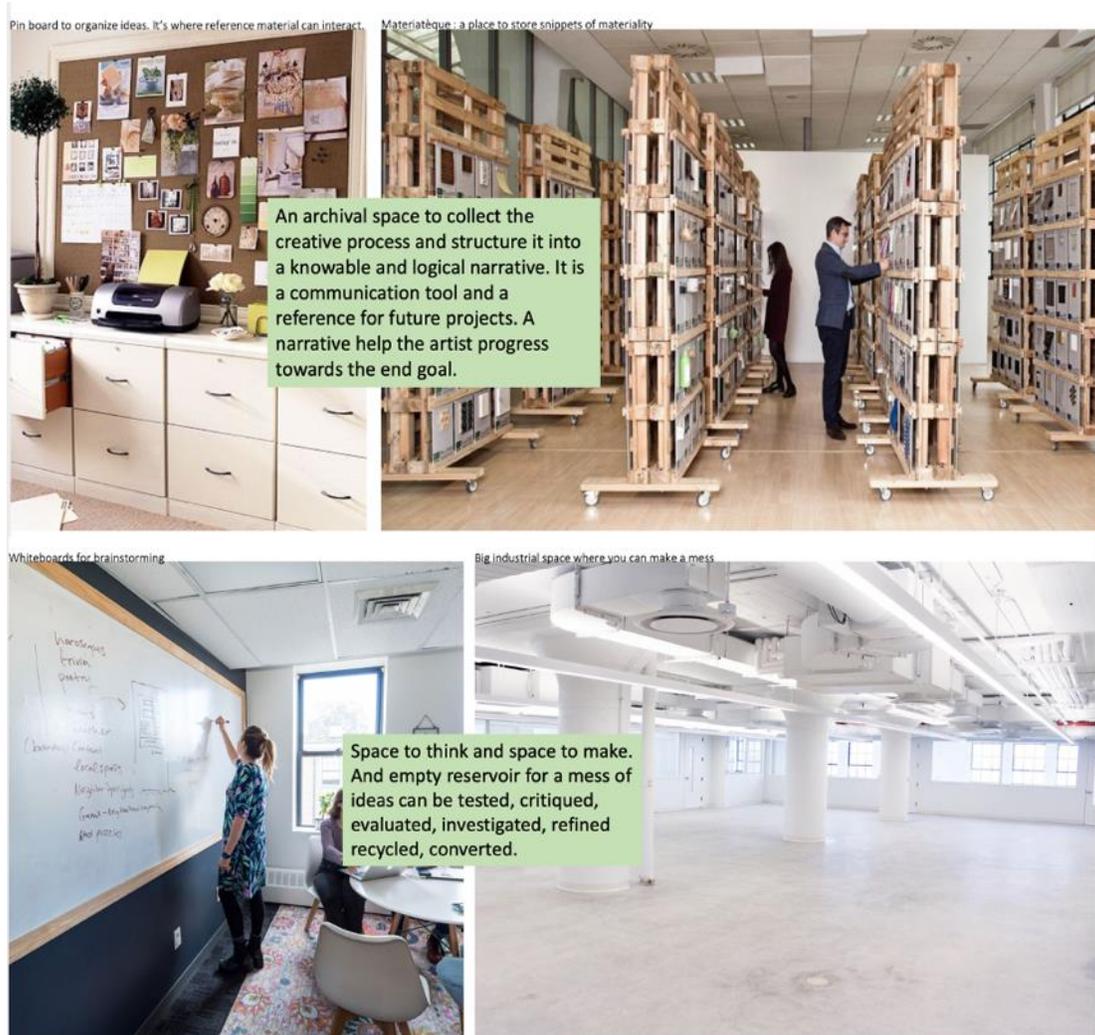


Image courtesy of Felix, DART 499/631

By contrast, Coney used metaphors that prompted sensorial affect, describing her creative space as the “*sound of two sides:*”

Countryside - Birds, sheep, weather, conversations on the radio

Cityside - quiet street, kids playing, conversations in the house

Sound system in both

Sight: Spacious, large windows, space for material exploration, storage to

encourage more bodies of work.

Olfactory System: Tea, coffee, peat moss, rain, earth, fresh air.

Senses are a sign we are alive, each moment we create another version of a story of which we are in. The source of creativing [sic] for me is breathing.

(Coney, ARTE 432)

For Coney, an account of matter *mattering* (Barad, 2003; Haraway, 2016) involves a sympoietic confluence of multisensory agency to “*make with*” her in that space. In a similar fashion, Emery methodically listed “*things*” that would spur insight as much as creative action, visualizing and describing a space that performs both interoceptively and exteroceptively:

Inside the space: (A space where I can be ALONE) ...

Things.

A lighting setup for video making and camera work

A double monitor setup for video editing

Lots of coffee on standby

A record player so I remember to get out of my desk to change music

Lots of notebooks so I can write down my random thoughts without messing up the space with papers everywhere

Plant life, so it feels lively and fresh inside

I’d also have dreamboarding walls like in murder mystery shows so I can write out concepts in a designated space and also put photos and artworks that inspire me up.

Outside the space: I’d like my life to be a Wes Anderson movie.

My ideal studio would be a sickly cute, updated old building with big windows so I can look out into the street. (That fire station in my video is the ideal).

If I could, I’d love for my space to be inside a city centre with all the hustle and bustle, art scene, and lots of people watching opportunities. While also being close to a park or forest where I can go for walks and decompress and admire tree leaves.

(Emery, DART 499/631)

Figure 20

Emery's Inside/Outside Design for a Creative Space

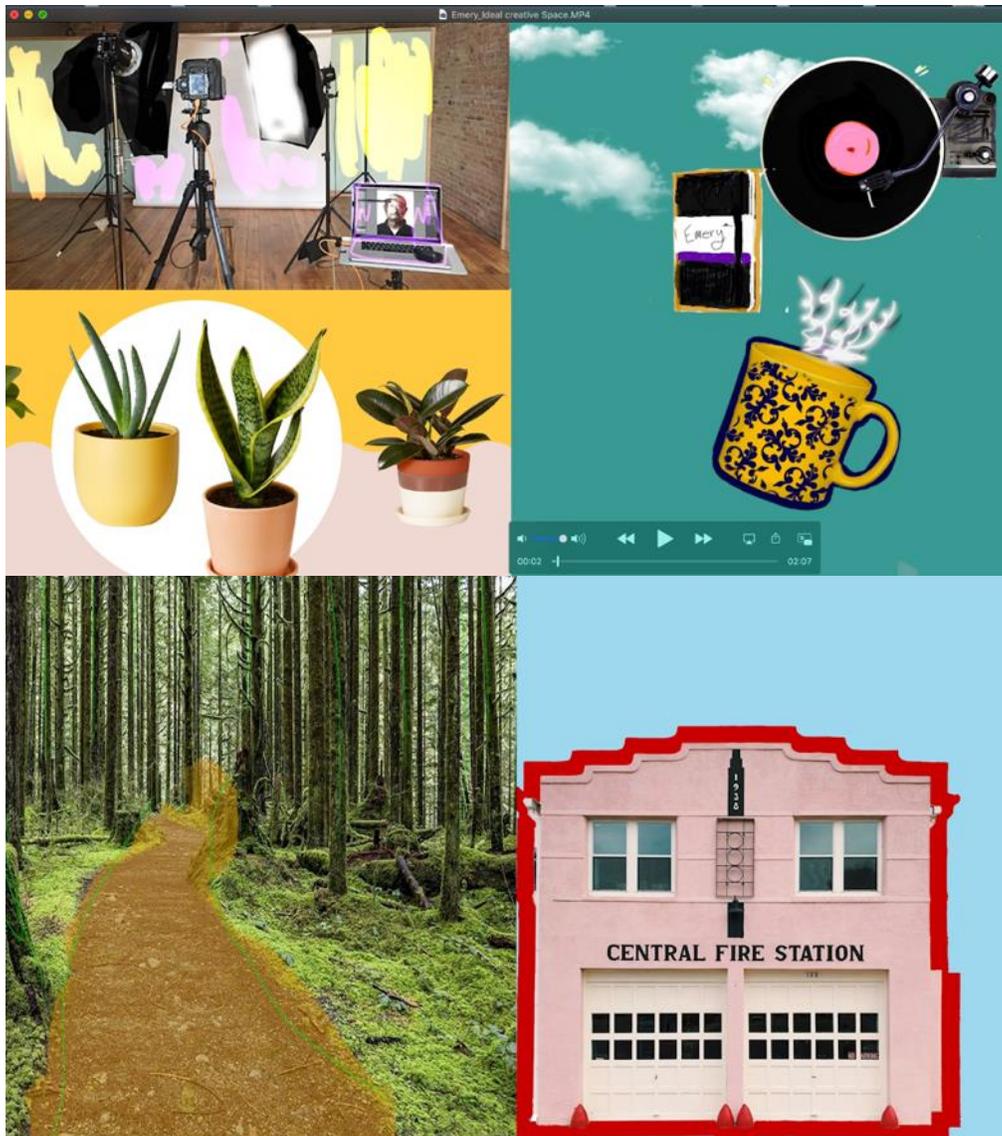


Image courtesy of Emery, DART 499/631

Note. The design uses both interoceptive and exteroceptive objects and images to express a Wes Anderson style.

Activity 4: Communicating a Complex Idea Through Artistic Expression

As a means of investigating aesthetic literacy and priming, this activity probed the use of metaphor as an operant in communicating complex processes. Students in each course were

required to select a process from an area of their formal training or personal interest that would be considered complex for others—such as what it is to be an art educator in training in a community setting, or how we see and “feel” colour (synesthesia)—selecting a metaphor to simplify its explanation for a non-expert audience. To query allegorical thought, students could generate a metaphor as a form of poiesis, expressing in multisensory ways the essence of a process or problem (akin to Vivaldi capturing the temporal effect of changing seasons through four violin concertos²⁴ or gamifying the progression of a virus), satisfying as many of the following multimodal/multisensory criteria (Boda & Fan, 2013) as possible:

- *Symbolic content*—no linguistic (verbal or written) cues (with the exception of poetry).
- *Media selection*—media and/or materials to be re-purposed from their original intent (i.e., found object, appropriated images, sound mashups).
- *Multimodal experience*—multiple senses should be engaged.
- *Interactivity*—viewers would be encouraged to interact with the metaphoric model rather than operate as passive observers.

This activity took two forms, owing to the curricular structure already in place for each course. In ARTE 432, students applied this activity to a visual journal assignment, with an informal presentation conducted online during the following class. During class discussion, students described the process of collaboration in community art education, activating this by creating individual visual metaphors, and in real-time, co-constructing visual narratives by creating assemblages with one another’s images.

²⁴ *The Four Seasons*

Figure 21

Metaphor for Service Learning and a Composite of Task-Related Images



Image courtesy of Eva, ARTE 432

Note. Task-related images are from a collaborative visual journal assignment, where students co-constructed assemblages of metaphors for teaching in community using shared image files.

Reflecting on this activity using the metaphor of a tree's cycle of growth, Jane wrote, *I felt like all the visual metaphors were building on each other, each explaining different bits of a shared experience. Instructors, students and observers are all 3 constantly feeding off each other. In their manner, they represent a cycle like a tree. They root themselves, share space, rain, sun and other experiences and create art. Their artwork's seeds will inspire others, and the cycle restarts.* (Jane, ARTE 432)

In another example, ARTE 432 students were assigned a reading on vulnerability (May et al., 2014) creating metaphors that represent finding a place for differentiated learning in the art

room. In response, Mon created an artwork about “building relationships” and “learning from each other.”

Figure 22

Mon’s Metaphor for Teaching in Community



Image courtesy of Mon, ARTE 432

Thinking reflexively about the challenges of meeting learners where they are, this activity formed new connections for several participants, reconciling multiple needs both for themselves as artist/educators and for their students. While Mon described these spaces as liminal and in-between, visual metaphors helped them to express what is often beyond the reach of words: *“I struggle to find the balance between all the elements that influence me in my journey as an artist and educator... For me my place is in the spaces between fiction and reality, flaw and perfection, breathing and drowning”* (Mon, ARTE 432).

Figure 23

Mon's Metaphor for Vulnerability



Image courtesy of Mon, ARTE 432

Note. This visual journal exercise culminated in a final portfolio assignment.

In the DART course, students produced and reflected on artistic renderings that would serve as metaphors for complex scientific concepts—such as somatosensory system of emotions, or pareidolia, the perceptual phenomenon that causes people to see patterns in random stimuli (shapes in clouds)—then submitted a proposal for a final assignment with sample images, video, sound, and descriptions. Using language such as “transformation,” “meaningful,” and “experimentation” in their responses, students considered the following prompts:

- Which criteria posed the greatest challenge?
- How did you reconcile multiple criteria in your final choices?
- What is the greatest challenge in simplifying a complex process?

- In what other contexts could you apply your learning through this exercise?

Manami’s use of metaphor in a video²⁵ is striking in the way it visually describes the complexity of affect and emotion, supplanting text with imagery that evokes sensation. Other responses traced a more direct use of metaphors to portray a scientific process artistically. In his depiction of pareidolia, Antoine used a visual metaphor to capture the effect of noise stimulation, demonstrating through datamoshing how affect/sensorial choices co-mingle with intensities/affinities for the artist/audience.

Figure 24

Milk Stories, Antoine



This algorithmic and collage bio-artwork uses EEG signal to generate fractal structures that in turn inspires pareidolia and altered perceptions. It intends to explore how figurative representations could emerge from biological signals.

(Antoine, DART 499/631)

Image courtesy of Antoine, DART 499/631

Note. Datamoshing artifacts of noise stimulation.

²⁵ <http://youtube.com/video/ANPGwMRVFPc>

Similarly, Emery's abstract imagining of the back of the cortex uses visual metaphors to map out and construct an image that incorporates how seeing contrast and colour occurs in the brain.

Figure 25

Emory's Metaphor for the Vision System

The world is made up of a contrast of light and dark are digital works that imagine the process of visual stimulus generating an image in the back of the cortex. Both pieces represent the Striate Cortex sending that visual information to the back of the brain. I used abstract art to tell this story because of abstract art's reliance on formal art rules like balance, negative space, color choice to convey a message, despite not representing the subject literally...



I found that the process of cells constructing an image in the brain uses those formal art rules to make sense of our visual environment. The colored work represents someone squinting into the light during a sunny day and the black and white piece represents what we see in the dark. (Emery, DART499/631)

Images courtesy of Emery, DART 499/631

Note: *The world is made up of a contrast of light and dark, an abstract imagining of the back of the cortex.*

Activity 5: Assessing Alternatives Using Counterfactual Thinking

In the fifth and final activity, I queried the effect of counterfactual thinking as a refocusing strategy. There are three stages of counterfactual thinking: activating prior memories, inferring possible alternatives based on salience and effectiveness, and adapting behaviour. Students were provided with a description of a problem requiring alternative solutions to produce a more favourable outcome or avoid an unfavourable one. Upward counterfactual thinking can be explained as—*if I were to do this next time, things may be better*, while downward counterfactual thinking as—*if this had also happened, things could have been worse*. I offered students in each class some examples to prime their responses: In the DART 499/631 class, the concept of seeing a film was raised, activating prior memories (for example, students could recall a time when they didn't like the film). From this, they could use counterfactual thinking to infer possible alternatives by defining how the outcome may have been different through changed behaviour (for instance, with an upward alternative such as seeing a different film or reading a review of it before seeing it). Similarly, a downward counterfactual approach for this example might entail—*at least it was a short film or COVID-19 restrictions have been lifted and I enjoyed going out*.

For this activity, students were asked to determine salience versus effectiveness and rate the alternatives based on their perceived effectiveness (i.e., would it achieve the desired outcome of avoiding a bad movie going experience?) or salience (would it increase the chances of enjoying a movie experience?). Whereas all salient choices are also effective, not all effective choices are salient. Brainstorming activities encouraged students to consider effective but non-salient hypotheses as well as downward counterfactual alternatives to determine how behaviour

is adapted, specifically responding in a post-task reflection to the following prompts in their visual journals:

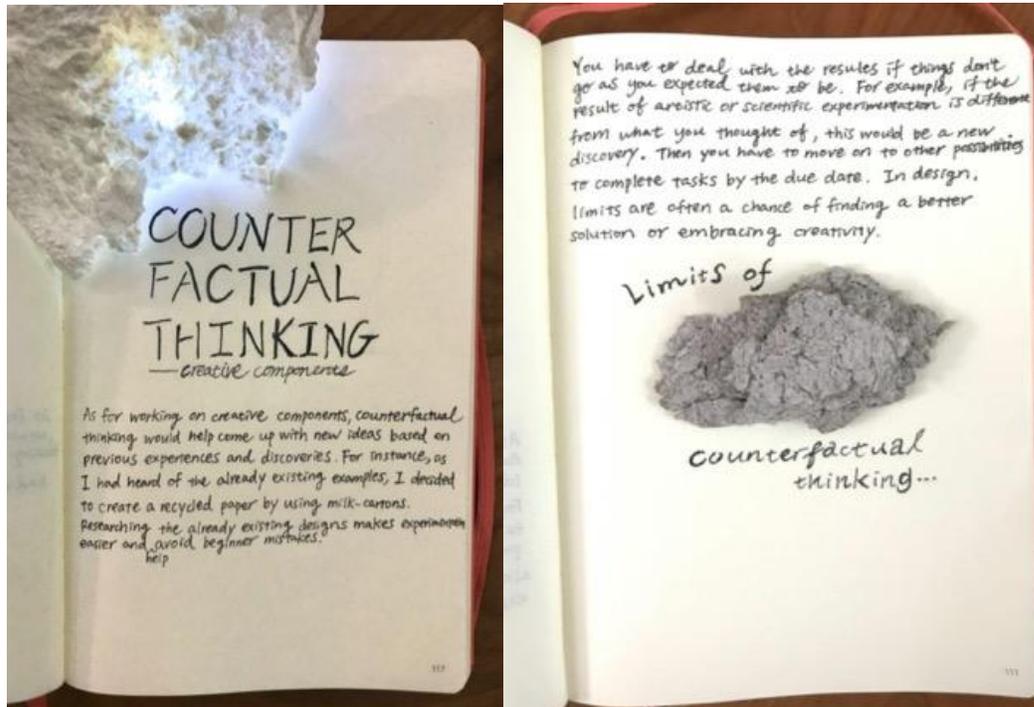
- Which upward assertion would you select? Which downward alternative would you most likely employ?
- How could counterfactual thinking be useful on more complex tasks, such as those involving creative components?
- What are the limits of counterfactual thinking?

Sample answers from participants in the Convergence course indicate metacognition of salience and ideation processes. Antoine offered that “*counterfactual thinking is a process by which the brain could construct emulations, which might be useful to test creative ideas with your imagination. We can gain insight regarding new combinations of ideas by the process of emulation*” (Antoine, DART 499/631). Amanda described collaborative connection as a pathway to disrupt a stagnating inquiry: “*Sharing gripes can be a good emotional outlet for frustration but can also be used to generate conversation that might allow you to get potential solutions from others*” (Amanda, DART 499/631).

Within the DART course, students used counterfactual thinking in a creative process through the documentation and sharing of process work related to a final cross-domain project. Manami’s visual journal demonstrates the divergent and convergent ideation process with her colleagues.

Figure 26

Manami's Counterfactual Process

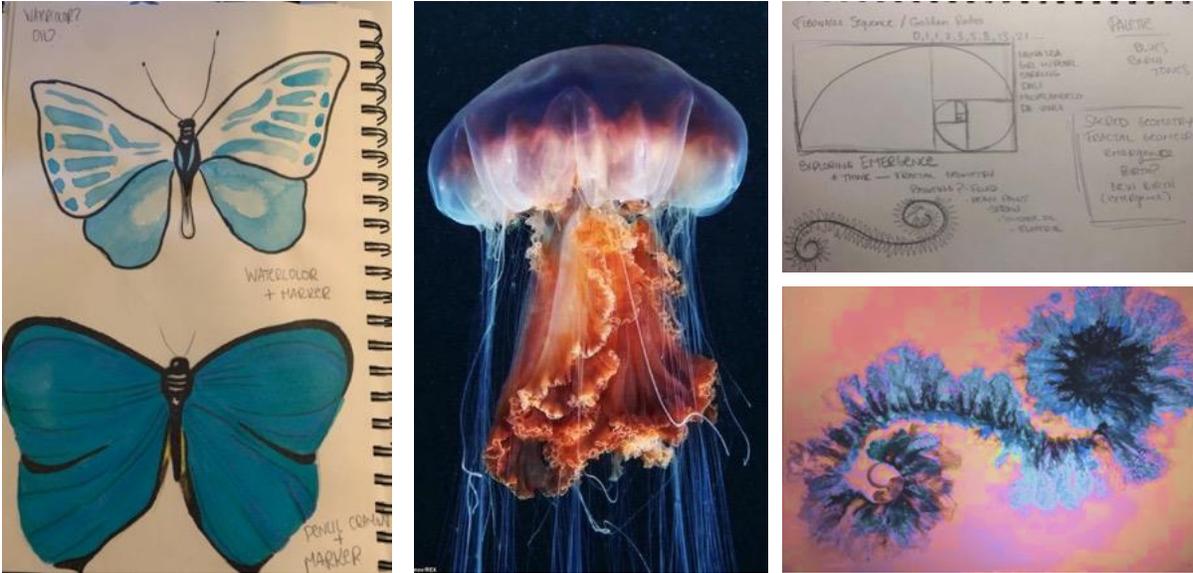


Images courtesy of Manami, DART 499/631

This activity took the same direction in the ARTE 432 course, with students exploring counterfactual thinking through the creative development process—the preparatory ideation and experimentation phase of artistic thinking. At this site, students documented their responses digitally and in visual journals through priming and metacognition, using preliminary sketches or thumbnails, compiling reference images, and writing reflectively about artistic assignments.

Figure 27

Eva's Counterfactual Process Seen in the Ideation Phase



Images courtesy of Eva, ARTE 432

Note. Documented through journal sketches and digital images, Eva's counterfactual process culminated in a final assignment, *Organic Emergence*, acrylic on canvas.

Figure 28

Kassandra's Counterfactual Process Seen in the Ideation Phase



Images courtesy of Kassandra, ARTE 432

Note. Kassandra's creative process used digital thumbnails to examine a new approach to materiality and hapticity—*what if different materials are substituted to express my concept?*

Chapter 4: Analysis of Diffractive Entanglements

This chapter analyzes the diffraction of responses to interview questions conducted with student participants as well as related content found in student visual journals: including reflections, artist statements, and artworks. Indeed, in the context of diffractive thinking, this chapter strays from a conventional consideration of qualitative data as *data* and re-materializes as assemblages of verbal and nonverbal “participant content,” the term I use here for my co-researchers. Within these diffractions participants and their content perform, co-constitutive of the propositions and their related concepts. Participant content was gathered from my co-researchers in the community art education course (ARTE 432) and from the Convergence art-sci/sci-art course (DART 499/631) and selected based on its relevance to descriptions of the creative process and the concepts identified within the first diffraction.

The structure of this chapter retraces the creative process outlined in Chapter 2, weaving together the emergent insights that unfolded from the participant content—particularly interview transcripts as these occurred after the interventions. With a view to transdisciplinary approaches to learning and knowing, a robust analysis of the propositions is advanced, focusing on the entanglement of creative process with intensities/affinities, affect/sensorial, and then process/relationality. Intra-actions between each proposition inform how artists and art educators operate within their own entanglements related to creative curiosity and inspiration, as well as the material and aesthetic development of an artistic concept.

Initially, I diffracted participant content to illuminate how it performs with the propositions of intensities/affinities during the preconscious and problem-finding phases of the creative process. Subsequent diffractive gestures incorporated the glow moments of the previous

diffraction, added to Table 9 below. For example, the intersections between intensities/affinities and affect/sensorial trace a transition from problem-finding to experimentation within the creative process.

Table 9

Sequence of the Creative Process Related to Priming and Participant Procedure

Stage of Creative Process	Art Theory Concept	Task-related priming	Non-task related priming
proposition: interoceptive → intensities/affinities ← exteroceptive			
preparation/ problem finding	desire plane of immanence	revisit past projects	walking (close observation) curation of the creative environment
proposition: interoceptive → affect/sensorial ← exteroceptive			
incubation	nomadic/ tentacular thinking	research	play experimentation with materials
proposition: interoceptive → process/relationality ← exteroceptive			
illumination	encounter	development of maps/plans/prototypes selection of prototype	engagement with other artists during pauses
FLOW STATE - (NsC Dual-Process Creativity)			
verification		counterfactual thinking	

Diffraction 3: Participant Content through Propositions

This diffraction is the product of the three propositions (intensities/affinities, affect/sensorial, and process/relationality) diffracted through the findings of the second diffraction between participants and the interventions. Each of the three propositions is presented in a different order in the following sections, as they relate to phases that offer an interpretation of the creative process informed by the processes and procedures of the participants. The first subsection considers intensities and affinities, exploring the disposition towards curiosity and the intuitive connections between personal narrative and the environments that participants co-constitute. The second subsection discusses affect/sensorial in terms of the relationship between interoceptive and exteroceptive influences on the desire to create, including environmental and material considerations as well as passive and active priming procedures. The third subsection, process and relationality, recasts various stages of the artistic process, illuminated by participant experience. Each proposition and the glow moments that emerge are folded into successive propositions to portray the pathways of flow.

Intensities (interoceptive) and Affinities (exteroceptive)

This diffraction revealed examples of the participant content through the individual concepts identified within each proposition. Having diffracted concepts of art education theory and NsC within the first diffraction, the concepts and dispositions included in this section are informed by the performativity of experience or expertise in a domain. In general, the interventions and interview content reveal a pre-existing disposition for creative work, diffracted through *désire* (interoceptive) and the plane of immanence (exteroceptive).

The dialectic between intensities and affinities within creative practice in this study produces a tension between the known or familiar and the novel. Affinities represent long

standing curiosities, preferred narratives, and signifiers, while intensities represent new stimuli. Even before one can assess intentional creativity, it is important to note that by way of natural or inculcated curiosity, the participant is aware of their environment and the connections they make between noticing, wondering, and creating a narrative or a concept out of the experience.

This disposition is clearly present in many participants who appear to have the cognitive/affective flexibility to readily generate salient ideations, as with the following examples: “*whenever I see something interesting that makes me react in some way or another, I would either capture it or I would just write down what it makes me feel.*” (Jane, ARTE 432). Multiple ideations can be combined in the preconscious phase: “*I think to me, creative inspiration is like various hypotheticals meeting each other and they make friends*” (Emery, DART 499/631).

Individual dispositions also have an impact on the perception of creativity and insight. For Emmanuelle, creative explorations need to be grounded in knowledge:

Yeah, it's all about knowing the truth ... when you're creating, you don't really think about all that research you do, I guess. But for me, I like looking into things to kind of make that kind of meaning behind my art even more. (Emmanuelle, ARTE 432)

For Coney, it is connected to the discourse within the artist community: “*I love art talks...any talk, in my background*” while Eva traces artistic dispositions to her family:

I feel like [it] could be in the way that you were raised and the way that your parents taught you to see things and what they kind of opened you up [to]—like, what they showed you, and if you were surrounded by art, surrounded by music. I wasn't necessarily surrounded by art, but I was surrounded by music a lot. (Eva, ARTE 432)

As a counterpoint, some find expressing their creative connections is more ephemeral, like Felipe, who surmises “*sometimes my creative inspiration doesn't feel like it's mine.*”

With these observations in mind, the reciprocal connection between insight, ideation (narrative construction), and evaluation depends on the habits (procedures) the participants intuitively followed to uncover novel connections. Turning to my own journal notations, the idea that metacognition is more of an afterthought than an a priori approach is laid out: “*I wonder if a 'preconscious' sense in creativity is similar to flow in that it triggers more of a reactive than proactive state*” [personal communication, May, 2021], suggesting that expertise and familiarity with creative work establishes a pre-existing openness to novelty and salience, which hints at creative ideation being as much, if not more, dispositional as procedural.

Désire and Interoception. *Désire* is an abundance of curiosity that motivates the artist to explore a number of lines of thought, each with the potential to evolve into a creative inquiry. Once again, it involves a state of ambiguity or unfulfillment, which is resolved either when the inquiry is replaced by another more compelling thought or by creative action. The examples that follow outline the interoceptive preparation for salience and the ability to make remote connections fluently:

Kassandra recalls the energizing quality of ideation and its connection to action:

I couldn't even sleep well because I had projects in my head that I would have never thought of having. But they were there, and it was like they were telling me, 'You gotta do it, you gotta do it.' (Kassandra, ARTE 432)

Amanda articulates a similar mindset, where curiosity encounters imagination:

I don't know how not to be inspired by everything. ... do you remember when you were a kid and you used to come up with all these things or pretend things look like something

else? I like to visualize all the different ... things that I think and I'm aware of, and the different ways they're synaptically connected and end up forming complete ideas.

(Amanda, DART 499/631) [original emphasis]

Désire is portrayed here as the capacity to make connections and to ideate—experience that both increases the speed at which this can happen and the flexibility with which it can occur. For both participants, insight is perceived as a force acting upon the self rather than as an intentional act projected outward from the artist through executive functioning or choice. Additionally, the ideation appears to occur frequently, accompanied by an intensity of response. Based on the content of the ideations, *désire* performs in these students as a dispositional readiness and cognitive flexibility to make new connections. My field notes query this meeting point between capacity and *désire*:

The ability to realize a vision may increase [students'] willingness to take risks and accept greater rarity in their process of ideation. Experience with dwelling in spaces of ambiguity and resolution, success and 'failure', will augment any disposition to pursue a hunch—even partial resolution is accompanied by insight. [personal communication, n.d., 2021]

Désire cannot be manufactured per se, but its intrinsic motivating force is consistently seeking that intrinsic reward of new knowledge.

Plane of Immanence and Exteroception. The plane of immanence is an anticipatory state where the participant experiences a heightened level of noticing. The brain is sensing there are meaningful connections to be made but has not yet moved to a conscious state. As such, the artist is open to a greater range of stimuli, increasing the chance of a more remote, rarer connection. Coney describes with clarity the elusive characteristics of the plane of immanence:

“it's almost like a rumination, so it's like you're hovering over ... a space and you want to stay there. It's like you're...gliding along and then you're like, ‘oh, what's here?’” (Coney, ARTE 432). Further on in our interview, she adds an intriguing paradox: *“I think it's just like, the fear of the unknown, right? It's the fear of the unknown. You want to do the unknown perfectly,”* outlining the occasionally ambiguous, recursive sequence of curiosity, noticing, and desire to create.

Turning to my own notes, I can see how these expressions of anticipatory wondering convey thinking-with and feeling-with:

[Within learning contexts] the plane of immanence tingles the senses with an expectation that ‘there might be something there,’ hinting at the promise of surfacing, much like the way a diver deep in the water—there, but not quite there —rises to appear from some unknown place. The embodied effect of anticipation is transcorporeal, palpable, a memory of something not yet experienced. Challenging learners with both restriction and possibility such as forcing connections between disparate objects or noticing what they would not normally notice through ROAM cards may not result in any task-related insight, but it invites greater metacognition. [personal communication, February 26, 2021]

Metacognition. Participants in both ARTE 432 and DART 499/631 showed an awareness of self-in relation to sense-making and storytelling through their artifacts. Interviews and journal entries will by their nature activate metacognition, at least retrospectively, and yet the ability to describe processes and procedures in detail reveals a lucid level of introspection. In the comments below, participants translate interoceptive and exteroceptive influences with insight and clarity.

Given that affect and mood have been expressed as pivotal to sustaining creative flow, there appears to be some clarity in the interrelationship among self, process, and procedure. If creativity is a derivative process, establishing the primary conditions that produce that mood may be a product of experience. There appear to be multiple levels of metacognition, awareness of concept, awareness of capacity, awareness of media and materials and awareness of context. Emmanuelle (ARTE 432) experiences a creative mood as an introspective process and describes how it becomes translated into expression: *“it's more reflective and it's more realistic in the moment: ‘oh, how am I feeling at the moment?’, ‘What do I wanna share?’, ‘I'm going through this right now.’”* Felipe acknowledges the tension of ambiguity and complexity in the process and the placement of self in the assemblage: *“I don't think creation is a simple thing. It's a mix of getting out of your comfort zone, being content with yourself”* (Felipe, ARTE 432). There appears to be an innate metacognitive component within creativity because the filter of viability (salience) is applied as an additional layer to cognitive, affective, or physical processing.

Tentacular Thinking and Long-term Memory. These recall processes are influential in terms of a personal narrative—the sense-making of experiences (semantic memory) and storytelling (episodic memory/imagination). As an artist, I meet these processes in a familiar liminal space where all the entities of lived experience and memory coalesce with possibility, a space where the human experience of materiality and the agency of material itself move in concert with imagined becomings, operating rhizomatically both toward and away from one thought and the next. Tentacular thinking draws from multiple sources (memory, current stimuli, affect, materiality) and combines them in novel ways, arriving at narratives that provoke creative ideation. Chanelle-Lize identifies the struggle to manage ambiguity and access resolution by gathering disparate ideas into a concept: *“I kind of see it as, like, a haunting because there's just like one character and I haven't,*

like, put/pushed [it] out on paper yet. It's just really like juggling ... she's like a ghost" (Chanelle-Lize, ARTE 432). Antoine sees the benefit of encountering this uncertainty as productive to making connections with his own narrative:

I need to have some places that I don't know ... I'm sure that I need to pass through those; [at that point] I'm starting to kind of shift the events that are happening in my life into a metaphorical representation. (Antoine, DART 499/631)

Memory activation is part of problem-solving and generates an internal gathering of archived stimuli, which can be as remote as an external encounter. Reflecting on a student comment in our online class discussion forum: "*I never had online class before or simulated teaching class. It is absolutely strange and also kind of frustrating and stressful, but I find it quite interesting at the same time*" (Ghena, ARTE 432), I noted in my teaching journal:

I have asked my students to think of childhood memories or wonderings to prompt their artistic response to [learning in] this [virtual] space. If there is a tension between semantic and episodic memory, it is episodic that appears to provoke creative ideation. As much as forcing rarity is effective as an exercise, self-curated prompts can probably achieve more meaningful connections. [personal communication, September 29, 2020]

Encounter and Exteroception. Encounters are a salient intersection point between the familiar and the novel, salience having been framed in long term memory. An encounter can be generated intentionally through priming or by noticing something in one's environment, an emotional response, or a randomly generated sketch. These examples do not necessarily entail all encounters becoming motivating insights; the problem-finding process often requires more refinement through research and experimentation. However, minor insights may become archived as a salient reference point for future connections.

The path to encounter is variable: in some cases, the encounter is attached to emotional response. Jane offers that: “*sometimes when I have really huge highs or huge lows, I tend to use them to fuel my creativity in a way*” (Jane, ARTE 432), whereas Emmanuelle gathers experiences connected to her research: “*Everything that I come to research ... influences me in my work in some kind of way, and I try to kind of merge it with how I am, how I feel*” (Emmanuelle, ARTE 432). For the majority of participants encounter is less haphazard—rather, a product of the practice of sense-making with the self. I also noted that it is only partially rewarding: “*Inspiration (insight) seems to transcend ‘encounter,’ there needs to be more than a noticing of something new—there needs to be a call to action (affect)*. [personal communication, n.d.]

Counterfactual Thinking. Counterfactual thinking is both a cognitive and metacognitive means of problem-solving by imagining a variation or inversion of a known context. It allows the participant to reconsider an inquiry and uncover possible extensions out of creative blocks by returning to divergent problem-finding processes and envisioning possible (and impossible) outcomes. Coney illustrates that this process is similar to insight:

Sometimes it's really strongly an 'aha' moment: 'I'm totally not doing that anymore. This is what I think I need to do', and then sometimes it's a gradual thing where it's like, 'OK yeah, maybe I should go look at it and flip it upside down.' (Coney, ARTE 432)

Regardless of the degree, a component of evaluative cognition is the product of focused thought or hypofrontality (Ellamil et al., 2012). Over time, counterfactual thinking can become habitual, a metacognitive way to return to a problem-finding/problem-solving phase.

Within the creative process, metacognition brings an initial ideation into clearer focus, assessing what is present and absent from the narrative and what supportive learning needs to occur through research and exploration of the idea. Further, it troubles the transition from

ideation to artefact by establishing salience between thought and process. Finally, it offers a top-down evaluative connection with experience/expertise to formulate modifications to artistic approaches through reflection.

In the space between priming interventions and metacognitive strategies, an idea emerges from an initial “sensing” and possible pathways to its expression. Evidence suggests that participants engaged in these processes intuitively due to previous experience or expertise, self-knowledge, self-awareness, and introspective dispositions. This assertion is not to imply that interventions are less effective in these contexts, but that the type and timing of priming and metacognitive work may need to vary according to domain, both within education and art-sci/sci-art initiatives.

Glow Moment from Intensities/Affinities

This glow moment pertains to the relationship of artist, media, and material—given the quantity of discussion around this within the interviews and given that, while unprompted, it surfaced with every participant. This connection raises another question around the relationship between expertise (previous experience) and sense-making.

Participants made the strongest metacognitive connections to material and media. Knowledge-building and refinement of procedure is one purpose for material and media manipulation, but experimentation offers novelty as well, satisfying a predisposition for a sensorial, haptic experience. Felix describes this affinity:

So [for this particular project] I was interested just in the materials. So sometimes I start with just the materials and I'm still ... I still have it in front of my eyes, [that is,] to try to come up with an idea for this material, so when something will pop-up or something will

connect, I will have it in front of my eyes and I will say, 'oh, I have an idea for that material.' (Felix, DART 499/631)

Chlöe offers an intriguing insight on materiality as restriction: “*I think that what I like about material is that it limits you. There's only so much that you can do. I feel like saying this is an 'aha' moment*” (Chlöe, ARTE 432). Facilitating a lesson on disruption sometime earlier, I had recorded a similar observation in my journal: “*I have noticed that my interventions, like material selection, are restrictive, as the need to collaborate with (or workaround) the 'givens' or limitations can spark ingenuity. Creativity needs a starting point, a context*” [personal communication, January 2021]. Part of the ideation and envisioning beyond the first encounter with novelty is material and technique, both as priming agents and an axiomatic component of the inquiry. Intensities and affinities are intertwined not only with the *what* but also with the *how* of a project.

Affect (interoception)/Sensorial (exteroception)

The first affect is related to a predisposition to respond creatively, an internal form of sense-making activated by feeling, mood, or empathy. It is an intrinsic responsiveness and a processing of a novel encounter. Emery (DART 499/631), for instance, when prompted to imagine an optimal creative space, suspended the mundane in favour of incorporating uniquely quirky and charming elements that might be found in a Wes Anderson film. Just as with intensities and affinities, there is an introspective, *interoceptive* assemblage that replicates the capacity for supranormal behaviour (Massumi, 2015), but the process is non-linear. The capacity and interest to convert the ideation into a prototype may be present, but internal or external restrictions may require the artist to defer or abandon the project.

When I enter my own studio, if the light is just so, if I have held back time and the daily demands of educator, researcher, mother, sister, and daughter—and as a monitor of dwellings, nourisher of beings, and minder of spaces—I am able to become-with the act of painting in ways that transcend my external performativity. My intra-actions with light and space, with colour and feelings, posthuman thoughts bound by real and metaphorical strings (Haraway, 2016) weave themselves into the space between brush and canvas, enabling me to slip beyond spatio-temporal experience and into the imaginary of co-creation.

The sensorial quality of artmaking is not only an engagement with the materiality of a medium but also the agential capacity of an artwork to generate an aesthetic response. Some participants noted that the materiality of the media itself will influence their connection to an artwork. For example, a few participants find working with a plastic medium such as paint or clay is more rewarding than a digital one. As Manami recounts, “*When I’m touching the metal pieces or wood pieces and trying to prepare them before I start cutting it, or when I’m sanding the wood, I really enjoy doing it*” (Manami, DART 499/631). Similarly, creative interest in a project may be revived by shifting to a different material.

Self-Curated Priming and Insight (exteroceptive). For participants, there appears to be a distinction between personal creative work and instrumental creative work (such as for an assignment). During instrumental work, parameters and restrictions prime the creative process initially along problem-solving lines rather than through exploratory inquiry, with the majority of task-related priming supplied through initial assignment criteria and contextual research. More time is spent in convergent thinking and prototyping rather than divergent thinking—such as generating alternatives. This was seen, for example, in Eva’s approach to ideation for a final assignment during which (as shown in Figure 27) she moved from one concept to another after

further contextual research and the new insights that followed. Non-task related priming tends to be much more personalized and considers images, artifacts, or environmental manipulations that facilitate mind-wandering or hypofrontality. An example of this was seen in Felix's materials boxes (Figure 19) which included objects (manipulatives) that engage tactile and haptic sensorial stimuli.

No matter the type of priming, the completion of a task is satisfying, although non-task related priming is dependent to a greater degree on extrinsic motivators, such as whether and how the work is shared. If the work is for public exposure, there remains some uncertainty regarding its reception. During one class, Ghena described the inherent tensions of such exchange in her role as an artist and educator: "*You sometimes have to put yourself in certain positions (of vulnerability) to be able to share effectively. It's essential to build the trust required to nurture learning and knowledge*" Ghena (ARTE 432). Sharing contexts can also have a detrimental effect: "*It shuts me down because my art is something that's very personal—what I am feeling right now*" (Kamila, ARTE 432). Conversely, many participants enjoy the exchange of ideas that comes with shared studio spaces, where consultation and peer feedback on becoming work is relished for the priming it provides: "*When it comes to sharing my work online, I would put it up there so I can talk to my friends about what I'm doing and either get input or just talk about concepts*" (Mon, ARTE 432).

There appears to be a greater relationship between an inherent desire to create, a current inspiration, and the mood or affective state of the participant. Of note, most participants (12/17) specifically mentioned spending time in a posthuman, *natural* environment—useful to recalibrating mood or to gain distance from a stagnating inquiry: "*having no distractions and being in nature all the time to just sit and be like: 'OK cool', like relax, that is very grounding for*

me” (Tallan, DART 499/631). Emmanuelle re-creates this sensation virtually: “*In order to get that inspiration, I can visualize myself next to the river; I can visualize [sic] the sound of the water and I kind of put myself in that space ‘cause sometimes you can’t be there* (ARTE 432).

While there are contexts in which priming the creative process may be intentional (as in a regular practice), it may not necessarily produce insight. In some instances, too much interoceptive or exteroceptive interference occurs that cannot be sufficiently suppressed, thereby becoming a distraction or negative disruption in the priming process. In one case, it is an abundance of choice that is distracting: “*There are too many brushes and colours. I want a limit ... I want a palette ... something that constrains me, and I don't like the open endedness of the colour wheel on digital art platforms.*” (Chloë, ARTE 432).

Self-curated priming is divided among exploring new materials and methods related to the novelty of learning, tracing and retracing past projects that mark waypoints of a longstanding artistic exploration of an idea, research into topics and concepts piqued by an insight experience, and the set-up of a creative space containing a blend of task-related and non-task related priming materials. Mon, for example, takes a rigorous approach to priming, revisiting previous artworks to stimulate the ideation process and generate new ideas:

I'll go through all of my sketchbooks ... or all of my drafts. Either all at once—on a big table I'll lay them out so I can see everything—or I'll go through them one by one. It sort of depends on the day. And then I'll mark out the things that I feel like I'd want to take.

(Mon, ARTE 432)

The practice of revisiting previous work speaks to engaging with concepts particular to the individual, thereby adding dimension to an existing creative pedagogy/ecology. This tendency to connect to past projects affirmed an assumption I had recorded in my journal: “*Priming as*

disruption can be effective in some circumstances, but experience and expertise appears to connect new inputs to questions residing in long-term memory more easily if the priming content is self-selected.” [personal communication, n d.]

Mood (Interospective). The “right” artistic mood appears to co-occur in two ways: 1) as a means to generate ideas and 2) in the desire to create. Processing strong emotions and moods may operate as a stimulus to make novel connections; the energy is channelled into the creative act. In terms of the motivation to create, idea generation requires some awareness of the creative value of the mood as well as the perceived need to extract the insight while the experience is recent. Underscoring this, Jane describes how she puts into action her creative mood:

Sometimes when I have really huge highs or huge lows, I tend to use them to fuel my creativity in a way, before my defensive mechanism[sic] makes me try to erase it from my memory, or just keep it as a random souvenir. (Jane, ARTE 432)

In this second sense, for many participants mood is imperative to actually doing creative work, which suggests that finding effective priming tools that connect to mood, either subliminally or metacognitively, is worthy of exploration. Moreover, as Antoine explains, mood and opportunity are connected: “OK, I have free time today’... and I feel in a good mood ... and I will be creative during that day.” (Antoine, DART 499/631)

Mood can be attained or sustained by non-task related or environmental priming, as Eva attests:

I definitely listen to music. It depends what my mood is. Usually I listen to ... lo-fi, which are just like calming beats, but if I'm in a specific mood then I'll probably listen to Elton John or Pink Floyd. Because they make me feel good. (Eva, ARTE 432)

Eva links her mood directly with making the space for creativity: “*I think that you really can't have one without the other. ... I know that I'm a very empathetic person and ... my surroundings affect me, you know? So, I need that right mood setting*” (Eva, ARTE 432). Whereas for Mon, the creative experience *provokes* an energetic mood: “*I think that like, for a lot of people, art is an outlet, so as they do it, they get calmer. But for me, I get very, like, much more stimulated*” (Mon, ARTE 432). Mood is derivative of circumstance, but the opposite is also true—it can be mitigated to some degree by executive control of the environment.

Materiality as Sensorial (Exterspective). A significant proportion of the participant responses were centred around materials and their properties, their potential, and how they performed in the creative process. Materials alone can be the focus of an inquiry rather than instrumental to it, as they permit an autodidactic, proto-creative assemblage that expands the repertoire of knowledge and skills for future work.

It's almost like a conduit, once I'm open and I'm like, I'm doing something with clay, then the conduits open. I'm receptive, I'm receptive, and then I'm like, here, here. But then I, then I shut it off. Because too much is no longer me being informed, and then I like to take those three or four things and then interpret and play with them and then decide which elements I want to use. (Coney, ARTE 432)

Kassandra, as well, feels a visceral connection with media manipulation:

Well, I feel like in terms of techniques, and the way you use your body, I have a stronger connection [when] I'm able to create something just by using my hands. And that cuts a little bit when I need to paint. I guess it's because I'm not using my hands directly, but... there is a link. (Kassandra, ARTE 432)

The entanglement of concept, materiality and technique affirms the complexity and variability of creative inquiry. Managing the tensions of multiple, non-linear assemblages that need to be navigated both internally through the artist and externally through material agency and cultural discourse is a process resisting a comprehensive portrait. The next section aspires to compile and consolidate the previous propositions into a rough outline of how the participants engage with the various stages of the process itself.

Priming with a Curated Environment (exteroceptive). Dul (2019) proposes a “triple path theoretical framework” (p. 483) to describe how the physical environment may link to creative production in an individual. Components such as location, building, space, and the elements within it (such as furnishings or tools) influence both functionality—meaning that perception of the space as suitable is imbued by the user—and mood, meaning that ambient space enhances or detracts from creativity.

In my study, part of the ritual of self-curated priming or preparatory work involved setting up a creative workspace with task-related materials. The selection and configuration of the space mirrors the connections between affect and sensorial as the sense-making and narrative of media, material, and ideation become-together. One student referred to her bulletin board pinned with notes and samples of task-related work as a “conspiracy board,” representing elements and connections among concept, material, and technique. Another participant described their bulletin board collection of images and tokens as a “personal Pinterest board,” while yet another referred to it as a “mood” board, a term commonly applied in the field of design. Felix shared his workspace and the need for material priming objects over a video call, carefully pointing out each feature:

So, I have ... an image of pinboards here [Felix shares his screen]. So that looks a lot like what I'm doing. Uh, but I have also, like, an archive. And for me it's boxes, so I put everything archived in boxes that I can pull out and refer to. But it's ... to me, important when you're working with people to be able to take the object and share it in your hands. So ... some type of archive. I call it 'material tech'.

I like to be able to test ideas really quickly, so when I'm somewhere where I have access to a shop, tools to make my maquettes, that really helps me. Otherwise, I really like to put the stuff I'm working [with] on the walls, have it close by, have it on my table, and that way I can have it in my hands while I work on my computer. ... I like to have people in the same place when I work on ideas. (Felix, DART 499/631)

Recollecting the importance of tactility in a similar fashion, another student described the sensorial experience of engagement with materials and the influence of interoceptive and exteroceptive factors on his mood:

Well ... a feeling in your hands, the brushstroke, for example, or feeling in your hand the drawing, the texture of the paper when you're using your colour crayon. I also have music going through my brain and for some reason, music will also generate memories at the same time. (Felipe, ARTE 432)

Here, consciousness about his environment and the exteroceptive process is texturally vivid: openings can occur, allowing for the shift to more interoceptive generative components. Amanda describes how proximity to others is stimulating, especially through her experience within an art-sci/sci-art context:

I love [the] perfect interchange between 'meetup and discuss' and then 'go off and do your thing'—that, like, you know, continual back and forth ... It was really invigorating

to do this class, to talk to people who are, getting degrees in the arts or who are also artists and scientists. (Amanda, DART 499/631)

Glow Moments for Affect/Sensorial

Glow Moment: Priming in the Posthuman Turn with Nature. One unanticipated effect of the assemblage among participants was the dual process of incubating ideas within the unstructured sensorial experience that nature offers. Many participants expressed a need to connect with natural surroundings before or following focused work. Beyond a desire to put distance between themselves and the project by walking in a neighbourhood, being “in nature” is seen as perceiving natural sensorial stimulation. Being in nature helps to situate oneself in space, adding a layer of environmental awareness that engages both metacognition and hypofrontality.

Coney understands the relationship to walking in nature as positive disruption and as mind wandering:

Oh, I seek it out. For sure, I will seek it out. But like I said, I feel like it's a subconscious symphony where I can just be walking through a field, and suddenly the three things that I was thinking about over the last two years gel [Coney claps], and I'm like, 'Oh yeah, that would work.' (Coney, ARTE 432)

A significant number of participants consider some connection to natural spaces as an essential component of their creative experience. Moving through space engages noticing and activates curiosity, and participants will collect images or narratives that intrigue them (akin to the priming activity of building an image file). Wandering with a disposition to observe increases the probability of remote connections but could also serve as an opportunity for mind-wandering (*dérive*) or hypofrontality to occur (see Debord, 1958; Laszcik Cutcher et al., 2015).

Antoine, explaining his noticing while walking, inadvertently describes the concept of “rarity”:

It's this idea of aberrant salience. So, it's the idea that there is saliency in things like little contrast that some people will not pay attention to. But if you pay attention to it, then it can really absorb you somehow. So, when I walk in the ... in the forest, sometimes I'm like, 'Oh, have you seen, like, the colour of that rock?' It's not everybody who will like to take the time to look at all those details, but sometimes in... in the details, I felt there is so much bigger [information] in them. (Antoine, DART 499/631)

Even when it is not readily accessible, nature creates a strong affective pull. Emmanuelle describes her priming process as she works on an installation that is intended to be site-based:

In order to get that inspiration, so [that] I can visualize myself next to the river, I ... visualize the sound of the water and I kind of put myself in that space, 'cause sometimes you can't always be there. I'm not from Montreal, so I'm not used to the lack of nature and natural things around me. (Emmanuelle, ARTE 432)

Glow Moment: Confidence. Confidence is a balancing of the knowns and unknowns of each inquiry, including one’s own capabilities. Felipe shares this experience in terms of measuring perceived ability to risk-taking: “*A challenge to creation is actually being able to release that fear of creating something beautiful and along the way, make a big mistake that is gonna take away the beautiful that’s in it*” (Felipe, ARTE 432). Sharing a partially formed concept may be difficult; the visualization may not lend itself to language at the early stages of an inquiry. Some participants do not discuss a project with others until the concept is at the prototype phase as it is still in the process of being resolved for them. Suppressing or overcoming uncertainty affirms the agency of the original ideation, which has been demonstrated

to be palpable. At that point, Coney (ARTE 432] acknowledges “*then you just brave the wilderness.*”

Glow Moment: Metaphor of Artmaking as Narrative Storytelling. Activation of semantic and episodic memory occurs within the noticing process. One participant noticed that only certain keys on her piano were dusty, which felt to her as unrealized potential (semantic memory); framing the key as “neglected” straddles meaning-making and storytelling (semantic and episodic memory). Imbuing this observation of material agency provoked possible creative avenues. Similarly, this preconscious phase is also described as a “story to be told” or a “character” waiting to speak. The assemblage of stimuli and connection to curiosity translates that relationship into a personification of something else, as with anthropomorphism. Seen through the lens of nonhuman theory, the recognition of agency in the object (potential and actual) helps to configure the concept. Mon outlines this agency:

Art is something that is like bringing the fantasy to reality. When you can see an image of something, the unreal can be real. And when you sort of begin to, it's just a little bit closer to the fuzzy barrier of reality when it's artwork that I can see and it looks like it could be a part of the world I see around me that is really special to me. (Mon, ARTE 432)

Further, Mon brings a sequence of connections into sharper focus while describing the relational aspects of nonhuman agency:

It's more like if I encounter ... a storyline, and in that storyline, there is a witch, and she might be a really minor character. Then for me, I start thinking about, you know, witches, and I'll think about magic and then that's when ... when that [magic idea] will go. And it might be a combination of things. (Mon, ARTE 432)

Affect/sensorial are generative forces. The impetus to connect with an idea, materials, and the environment translates pre-conscious sensing into conscious sense-making through the narrative metaphor. What is compelling through this active stage is combining knowings and doings, knowledge of the insight that drives an inquiry, and the sensorial input of the materials and environments that contribute to the processes and procedures. Body awareness, be it gravitating to a natural environment or through the coordinated motions when interacting with material, maintains a tension between metacognitive control and intuitive expression. Out of these awarenesses, a choreography of generation and evaluation unfolds through the creative process.

Process /Relationality

Participants maintain relationships on three levels during creative work: the relationship to the inquiry; the relationship to themselves as artists and the creative process, and the relationship to the socio-cultural milieu in which their work is exposed or exhibited. The relationality to the inquiry is powerful; it becomes a narrative that needs to be conveyed, if only to the artist alone as an audience of one. Developing, sustaining, and resolving an inquiry, however, appears to require a series of smaller, supplemental insights beyond the connection that drives curiosity as an affective motivation. An inquiry can possibly be supplanted by a different insight, leading to a completely different outcome, or result in the initial inquiry—though still intriguing—to become dormant.

For some participants, the intersections within the creative process are more than simply a pathway to producing something. There is intrinsic value in the process itself as the combination of thoughts, memories, insights, and projections of possibility can offer resolution in themselves, and further, wonderment at the achievement of bringing an idea into some form of

visible/audible existence. The meeting point between process and affect can be an embodied experience:

I wanted to be able to, like, physically immerse myself into the painting. ... So what's happening inside of me is ... I just feel, like, every force inside of me is going to be part of this idea, like, you know, I eat, sleep and drink this one idea that I've come up with."

(Mon, ARTE 432)

Mon's description reflects an optimal relationality among intensity, affect, and flow as the inquiry is sufficient to sustain itself. Uncovering dispositions as much as processes is relevant to an examination of process/relationality.

Another relationship is the context in which the art is being made. In some cases, connecting to a peer network during the creative process occurs only during breaks, and the work itself remains concealed until it is completed. Other respondents may consult trusted peers on a process, but then return to the unfinished work without it being seen. Still others will livestream their creative work in progress using social media as a form of affirmation. The advent of domain-specific online chat rooms and videos has also enabled broader avenues for participants to participate in the discourse about artmaking. Mon describes these connections:

Well, social media has brought me a lot of fellow artist friends, because one of the things that I think brought us together is sort of this shared experience of, like, an interest maybe in this particular kind of art, as well as the sort of concepts and media that are all involved in it. (Mon, ARTE 432)

For artists, the actual creative connection pertains to the *what* (idea, concept, theme) of the artifact. The *how* (materials, media, form, technique) is also germane to the process, particularly when experimentation with unfamiliar materials occurs. In both cases, there is a

divergent creative phase (possibility) followed by a convergent phase (experimentation and selection).

Preconscious Gathering (Problem-finding). Novel connections aligned with creativity primarily occur during the initial catalyst, leading to the *what* of the creative endeavour, mostly due to an intrinsic connection between long-standing curiosity and the immediate trigger. This initial phase may receive immediate attention or remain latent in long-term memory but is not forgotten or abandoned, even over extended periods (weeks, months). Described as a type of background noise, it can be partially suppressed but never totally ignored.

The experience of the initial insight (inspiration) arrives for many participants as a sudden and dramatic clarity of thought, but usually after some focused or subconscious reflection:

Well, for me it happens mostly, after I've done some research, after I had already this idea in my mind, going around and around. But there is that little thing that might not be quite there and then—poof! It just arrives. (Kassandra, ARTE 432)

For some projects, insight develops more gradually:

I think about people being like: 'ohh, yes, this all makes sense' and then they go and, like, create right after that, but for me it's like a bunch of little 'aha' moments that kind of come together and like: 'this might work'. And it happens over the course of, like, days to weeks. (Tallan, DART 499/631)

Eva's experience resembles Tallan's: "[T]here will be a whole, you know, research process that will help me. But creative inspiration in general, it's sporadic" (Eva, ARTE 432).

This preconscious phase appears to be characterized by anticipation and uncertainty. It seems to be a coalescence of noticings that generate an affective response. The connection of

noticings to resonant curiosities brings into focus the narrative behind the concept or idea. There appears to be a persistent desire to bring the idea out in a tangible manner. While describing her response to an intervention, Tallan acknowledges the impact of non-task related priming as provocative or disruptive:

a lot of those pictures that I may have put as not relating to the project, but like honing, like centering in on the project ... a lot of those photos brought up, like, an emotional feeling for me, that maybe I wanted to incorporate, but like, I didn't know ... it didn't, like, looking at it, I was like: 'no'. But it was the feeling that I got. (Tallan, DART 499/631)

Partially complete or intuitively generated concepts characterize the problem-finding phase. Identifying how to access missing information for context or technique via research (both visual and linguistic) determines the trajectory of the remainder of the inquiry.

Fomenting: The Importance of the Research Phase. Conventionally, a research phase serves three functions: 1) allow for focused divergent thinking to bring the idea forward into consciousness, 2) add breadth and depth to the context of the content, and 3) experiment with materials and techniques. With regard to the first function, the artist appears to learn as much as possible about the theme or narrative behind the work by reading and image-gathering. The second function is related to the first but focuses more on seeking exemplars by consuming aesthetic content or reviewing past projects (either archived artifacts or by consulting process journals). This is particularly salient because a sizable number of participants indicated that a review of their *existing* portfolio was essential, as the new concept often would build upon elements of past projects. In turn, this connects to two strands: the encounter of the novel with the familiar, and the nature of the familiar itself. Mon describes this phase, but interestingly their sense-making is, at first, language-based:

Sometimes I write it down. I find that I write things down almost more than I draw things out. And then once I have my idea, I like to collage my own work, so uhm, I like to take pieces that I've made, or I'll create a whole artwork and then another one, and then I'll sort of Frankenstein them together. (Mon, ARTE 432)

Whereas Amanda performs a form of diagrammatic mapping:

I've got a page in my notebook ... a garment, and over here would be like ... like, what type of cut? And then I'd do like a bunch of different pictures of different potential hems and then I'd circle 'handkerchief hem', and then I'd write 'handkerchief hem represents disparate parts.' I'd draw a double helix off the side view, like: 'integrate double helix'—question mark, hoop skirt. Do I make a hoop skirt?' (Amanda, DART 499/631)

An original insight can spawn multiple iterations of an inquiry or project even if the concept evolves into something else. Emmanuelle articulates the continuity of her artistic journey: “*I also am curious and was interested in actually, like, using those old projects and finding new ways to develop them.*” (Emmanuelle, ARTE 432). Iterations and alterations may occur even in the earliest stage of a project. Cassandra offers an interesting description of allowing hypofrontality to operate as a way to delay closure until the problem-finding phase is maximized:

When I've just started something without really thinking about it, then I find myself just so ... just so in over the painting, or just restarting the whole thing over and over. So that's why I just let it sit in my head, make sure that I feel comfortable with it, that ... that I have done my research, that everything makes sense, that, uh, yeah, I just need to go through a lot of, a lot of research, that's for sure. (Kassandra, ARTE 432)

Material and Technique. In terms of the *how*, choices made at this stage relating to media and technique can offer novel, stimulating work for artist participants, yet experimenting (at least during the initial phases) operates as a separate, playful enterprise. It is gratifying for artists to explore the materiality of a medium or process as a separate endeavour from the focused work of producing any artifact. As the artist progresses through this phase, lists and/or mind maps are constructed to guide the process and make all possibilities visible. Mon balances the intentional and the intuitive in this phase:

So, when I combine things even like with digital and then traditional media, that is really inspiring for me because there's certain effects and textures and ... those each lend themselves to different ... in narratively different aspects, so when I can combine all those different textures that I can achieve in different mediums, that's what I really like. (Mon, ARTE 432)

Jane, by contrast, cautions that research has its limitations:

So yeah, it's a part of trial and error and research. And then I try to combine the two to see where I can go with the technique and the message. So essentially you—as part of your preparation—you wait for... you wait for the spontaneous. (Jane, ARTE 432)

Arriving at a Plan of Action. The end of the research phase transforms into an iterative process towards the development of prototypes, sketches, studies, or thumbnails (less resolved, smaller scale versions of the sketched piece). These may be holistic representations of the artifact or a series of separate diagrams depicting details of the component parts. *“I have all the ideas; I have my little brain map. I will start designing, prototyping. I’ll make collage or vision boards”* (Emery, DART 499/631). Depending on the artist, several versions will be created, and the artist will select the final image(s) as a starting point. In a sense, this represents a shift in confidence as

much as in the creative phase as decisions relating to form, content, and context have been accomplished.

It's usually within an hour or two. When I ... when I get my sketch done, like that first initial sketch. And that's when I'm done doing most of [the] referential parts of my process. When I'm done looking into artists and ideas and stories, I think that's when I stop feeling insecure because I feel like I know what I'm doing. (Mon, ARTE 432)

This preparatory work alternates between problem-finding (choosing a compelling concept) and design thinking (choosing which strategy will best serve the project). Throughout these phases—which can progress in a non-linear fashion—insight may arrive at any point, informing form, content, or both. “*You start wondering about things, suspending disbelief, and then you can just tumble into a weird hypothetical situation, just needing to ask questions over and over again*” (Chanelle-Lize, ARTE 432). It is arguable that the *what* and the *how* of a project each have their own “aha moment” or insight: the first relating to original disruption, which operates as a catalyst between long term memory and working memory; and the second, when resolution of material and technique arrives at a prototype. This is supported by the conception of inspiration as a series of insights rather than one single vision.

After Inspiration: Self-evaluation. Cassandra notes that uncertainty can creep back in, even this far into the inquiry: “*When it's time to work with that inspiration, with those ideas, well, that's when you start getting a little bit more judgmental on yourself*” (Kassandra, ARTE 432). By contrast, Mon intuitively applies an intriguing evaluative criterion to select among prototypes:

It's sort of like in a reality TV show, where they have the contestants and they [compete] against each other. Then I'll take the parts I like, or I'll take the ones that sort of pass my

little tests (in my mind), and then I'll end up with the final, the final winner. (Mon, ARTE 432)

Environmental Influences. The culminating phase of preparatory work involves the interoceptive and exteroceptive environment of the artist. Lighting, temperature, ambient noise, clothing choice, layout of the space (including priming or reference materials), proximity to others (particularly other artists) were all mentioned as determinant variables that required significant attention before the “real” work began.

Interestingly, communing with other artists in the pre-work phase forms a component of the process for Felix:

Well, sometimes there's this thing where you explain something to someone and they don't understand it quite yet, and when they tell you back your idea it's better than what you had before. Or having to tell them your idea forces you to come up with a good explanation for your idea, to articulate it in an intelligible way. (Felix, DART 499/631)

On the other hand, for Eva, developing a concept requires isolation:

I know that I'm a very empathetic person and, like, my surroundings affect me, you know? So, I need that right mood setting, my music, I need to be alone. I need to know that no one's watching me. I can just be whoever I want to be and then also that all comes from within, right? That is all coming from me. (Eva, ARTE 432)

Felipe experiences a heightened sensory state, noticing and coping with ambient noise:

So, I would say that creation is a lot of overwhelmings, like, overwhelming stimulus. Like, a lot of stimulus [sic] at the same time. That's how I feel it. Even silence is a stimulus, because I get the sound from the fridge, I get the sound from the neighbour who's walking, the birds chirping if it's summer. (Felipe, ARTE 432)

Flow State. By the end of the research and pre-work phase, the conditions may be present to achieve a state of flow for an artist—an immersive stage during which focus is concentrated on the production of the artifact. Descriptions of the flow state were consistent across artist participants, capturing that sense of enthrallment and preoccupation with comments like *“I’d become immersed, and it just felt like the right thing that I needed to be doing at that time. My brain was like ‘We need to do this right now. This is what we need to do’”* (Tallan, DART 499/631). While creativity may be occurring in this phase through simultaneous selection and experimentation, the artist is relying on their skill base to enact the plan they have produced, aligning the artwork with the design.

Flow state appears to translate to executing a plan of action rather than making strategic creative decisions. In the artist’s mind, since the principal creative decisions have already been made before the creative work begins, full metacognition (awareness of the environment and the self) during the flow state appears to be counter-intuitive, meaning it is purely about progress as the artist is completely absorbed by the task. During the flow state, the artist is continuously alternating between generation and evaluation with a narrow focus, during which exteroceptive influences, other than the material and media, are configured not to interrupt the process. A sustained flow state can override perceptions of physical needs such as hunger, fatigue, and the passage of time.

My brain is usually kind of on a higher wavelength most of the time, and in order to get into that flow state, I really have to take a step back and, like, breathe. Maybe do a meditation and remind myself to continue breathing, have a really chill environment when I’m not going to have to be worried about ... people coming and asking questions, or being interrupted. (Tallan, DART 499/631)

Self-Disruption Through Pause (Verification). A pause in the working phase may re-engage behaviours described as preparatory. The artist actually seeks to disengage from focused artmaking due to physical or environmental limitations or a movement away from a state of flow. In some situations, an artist prefers not to engage with others during the flow state but rather isolate, yet the need to connect and become energized by the work happening in their various professional and social networks remains. In some cases, total isolation is necessary throughout the entire creative phase.

Jane articulates the need for disruption by pausing, a period during which she allows for the introduction of new stimuli through social contact, even if it is task unrelated:

But during breaks I do need the socialization, because sometimes I just stay focused for too long. I need something to cut myself from work and not work. But in between or after, I notice the social aspect really is something that I really need because it helps me consolidate my concept or figure out that it's not really working. And sometimes it's just from hearing them talk about their own work. It kind of motivates, it motivates me as well, and it makes me... you know how when you hear someone being passionate, you kind of want to be as passionate ... or it just, it contaminates you. (Jane, ARTE 432)

From *What* to *How* to *When*. As discussed earlier, one overarching principle of creative work is affective—“*I know that I'll always be in a good mood. I'll be focused, so that's what I connect creative inspiration to, it's like me being the best version of me*” (Eva, ARTE 432).

Affect is also a disposition that facilitates a flow state. “*The majority of it is done in that one sitting, and I feel like I'm in a bit of trance when I do it. My roommate might come in and talk to me and I won't remember what I said*” (Mon, ARTE 432). Massumi et al. (2019) support this contention: “Affect comes flush with the event, in the immediacy of its occurring” (p. 111).

Mood is more of an activation of affect rather than an emotional response. Although insight may be present, the disposition to engage in creative work requires multiple interoceptive agencies to align. Components contributing to a creative mood include confidence, competence, degree of inspiration, and the resources (time, materials, money) to devote to a project. There also appear to be situations in which the encounter is resonant in the moment, needing to be explored immediately, almost impulsively, whereas the same insight loses resonance over time, as with a sober second thought. This urgency illustrates the connection between *désire* and affect, although there is some precarity in its resolution. A notion may show possibility/salience, but it may not survive the final analysis of the brain's executive network.

Tallan captures the ephemeral nature of inspiration and the fleeting confidence some participants described in response to a shift in thinking when away from the creative task:

Sometimes I'll feel like I have an 'aha' moment when I'm out, and away from my work, and I'll be like: 'Oh my gosh, everything makes sense'. And then I'll come back to my work, and that 'aha' moment will have, like, dropped down a couple of degrees and it will just act as, like, one more stepping stone to the ... to the next. Which, maybe that's its whole purpose, right? (Tallan, DART 499/631)

Closure: The Acquisition of New Learning. The choice to end an inquiry to the artist's satisfaction is as much connected to the actualizing of a concept as it is to the focused or intuitive application of material skill. The resolution of cognitive and affective ideation and narration produces a form of learning connected to the reward impulse in the brain. Felipe offers that there may be inconsistency or compromise involved with closure: *"Sometimes it comes out exactly as I see it, sometimes it doesn't. But the image is there, and its details and its characteristics—colour-wise, everything is there."* (Felipe, ARTE 432)

For Ghena, certainty regarding closure can be as elusive as ideation, often resolved intuitively:

Actually, I rarely feel closure. So, I said that [I did], but ... I never feel it. And when I think 'OK, I could change that', there's this, uhm, discomfort in me. I don't feel that it would be right to change it. I think this is ... the breaking moment ... I think [then] I should put down the brush. (Ghena, ARTE 432)

By contrast, Emmanuelle characterizes completion as a point of new understanding: “When you understand the thing itself, I mean. I guess that's how ... that's the most important thing. That's how you can make the most relevant connections, in my opinion” (Emmanuelle, ARTE 432). Kamila approaches closure as a moment of evaluation: “It creates this distance and then you can analyze yourself and what you've just created” (Kamila, ARTE 432), whereas Amanda finds satisfaction in moving from artist to audience: “Yeah, when I'm done with the process, I want to become the audience and get the consumption to get my inspo back” (Amanda, DART 499/631). In terms of affect, Mon describes the trajectory of their creative process:

When I get that flash of inspiration, then I feel like my head is getting super full and only at the end when I'm all done, or when I'm happy with it, it's like you pulled the drain and then it all comes out. I don't necessarily feel like the art, that it's emptying. I feel like it's building, and then at the very end is when I am finally free from it, like ... or I'm finally empty. (Mon, ARTE 432) [original emphasis]

Transforming/Abandoning a Project. A project may be abandoned or rejected due to a lack of cohesion between the initial impetus and the execution. Participants describe losing interest in the project especially when satisfactory completion has not occurred for a length of

time. In most cases, the project is either transformed into another concept (restating the problem) or temporarily abandoned. By “temporarily,” I mean to say that the memory of past projects may re-emerge in the form of priming/research material in future inquiries. For the participants, “failure” is considered to be a lack of resolution rather than a mistake. Implicit faith in capacity with materiality enables experimentation, and when the experiment is not successful, it is often attributed to excess (adding too much), rather than lack of capacity.

Mon summarizes the tensions involved:

When things go wrong or things divert suddenly, that's—it's not a positive or a negative for me—it's just like a part of what's likely to happen, so I ... I try and enjoy it, especially because at the end when I've finished it, it's not like I'm regretting something, 'cause I don't know what would have happened if that diversion hadn't happened. (Mon, ARTE 432)

Jane, too, is able to use an “error” as a springboard for future work:

Yeah, I think most of the times it's when I do not know a technique particularly, and then I do a huge mistake that cannot be undone, but that mistake in itself leads to another type of project and another type of problem. (Jane, ARTE 432)

Kassandra describes the impact of media selection on iterations of a project:

I started with one medium and then ended up using something completely different. It did happen with clay once and it just wasn't feeling right. So instead of going with clay, I went with plasticine and then instead of plasticine, I ended up using metallic wire, and I don't even know why. (Kassandra, ARTE 432)

For these and other participants, the willingness to abide by uncertain and unanticipated outcomes is offset by the understanding that valuable learning is still acquired, which will likely be integrated into future work.

Glow Moments from Process/Relationality

Not surprisingly, some participants have a reverential, metaphysical relationship with what they perceive as the mystery of the creative process itself, believing it to be “sacred,” “magical,” and profound. The quest to achieve a flow state, the intensity of the moment where resolution is about to occur, then translating a concept into an artifact are described in almost ecstatic spiritual terms:

Oftentimes I have my peak experiences when I'm creating art ... there's this indescribable kind of euphoria or spirituality that's associated with just the process, but then also ... if the product turns out even close to how it's imagined in my head, it's like, wow! I... I'm capable of creation. And it's possible to instill all the things that you feel and think into the tangible world. And then I get all metaphysical about that. So, I feel like there's something kind of deep and beautiful there. (Amanda, DART 499/631)

Antoine echoes Amanda’s sentiment:

While I'm creating, I'm not [sic] thinking about nothing, you know, so I feel totally free. And I think it relates, it links me with my higher self somehow, like, there is a ... it's a way to communicate with your higher self, to express yourself, and then you know, creativity, it helps me to dialogue with my spirituality as well, right? (Antoine, DART 499/631)

Although each of the three propositions were discussed individually, it is evident that concepts overlap and co-mingle. They are interdependent, fluid, iterative, and recursive: inquiries that are principally material-driven may appear to depend more heavily on affect/sensorial and

process/relationality than intensities/affinities—and yet arriving at the choice to select a material, media or concept with which to engage still contains all three dialectics. Tensions between curiosity and uncertainty, confidence and self-doubt, learning and expression, expertise and experimentation, personal and socio-cultural contexts form assemblages that must be navigated through the process.

An overarching observation regarding artistic creativity with these participants reveals the dispositions with which they already work. On a meta-level, their experience or expertise requires much less executive brain function devoted to metacognition, even when they struggle during a phase. Experience also offsets uncertainty as there is assurance that the current inquiry is but one of many. Coney illustrates the cycle of thinking, making, and learning:

I feel it's almost like, um, a balancing act. It's like, you have to ... it's like when you work on the painting, if you get stuck on one corner, you can overwork a corner. It's like the same thing, it's like you have to kind of manage the full composition and to manage that, ... OK, it's the research, for sure it's the research. I love the research, but then ... I can't wait to get to the painting. Then I'm at the painting and, oh, I can't wait to get to the next set of research, you know? (Coney, Arte 432)

The individual concepts associated with the propositions, like stages within the creative process, are recursive and interchangeable. When taken together, glow moments offer both specificity and a broad perspective. The creative process is a composite of intention and expertise, realized through a combination of dispositions oriented around exploration and imagination. While procedures may vary, what also glows is the narrative quality of inquiry, both authoring and participating in storying the sense-making immersively, finding a reward intrinsically through the learning as much as through sharing with a community. From a posthuman perspective, the

agency of material is the most consequential aspect emerging from this inquiry. Material, media, and technique may be as valuable a component to a researcher as the initial inquiry.

Figure 29

Assemblages Combine to Form New Assemblages and New Meanings with Each Encounter

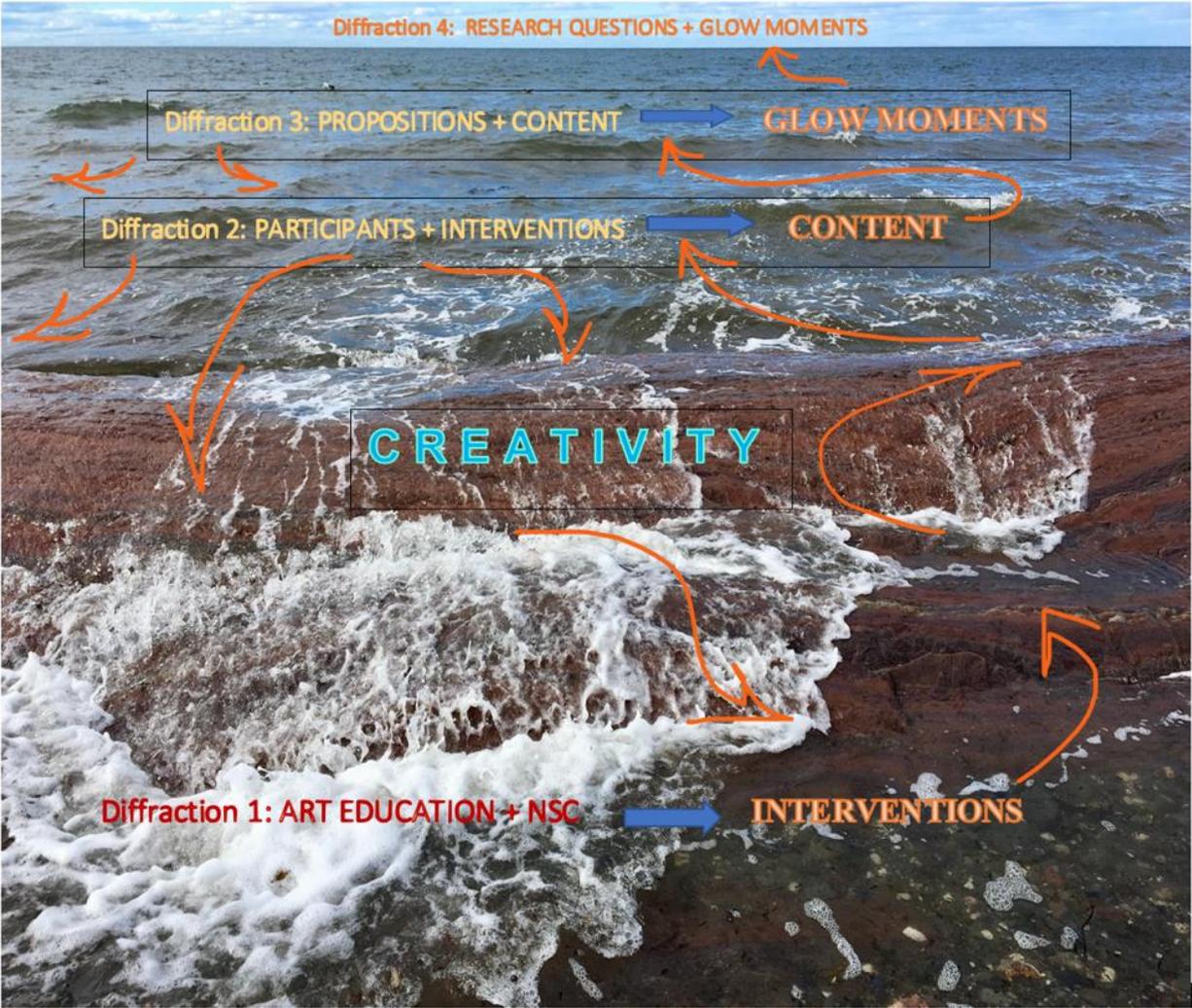


Photo credit: T. Osler

Note. Diffractive patterns of movement are wave-like, messy, and iterative.

Diffraction 4: Research Questions + Diffraction 3

In this diffraction, the research questions are read-through insights that emerged from the third diffraction. Stemming from the third diffraction are considerations of the propositions that influence each of the three principal research questions. Intensities/affinities relate to the personal connections between curiosity and memory; affect/sensorial is the inherent desire to create and engage with concept, media, and materiality, whereas process/relationality has been shown to have almost an ontological quality—an intrinsic assemblage with the artist all to itself. As personal as the creative trajectory may be, there are points where engagement with particularities of the process is beneficial. Diffracting the three research questions through the third diffraction (the combination of Diffraction 2 and the propositions), reveals the relevance of the interventions, the timing, and the context in which they are applied, as well as the querying of concepts proposed by NsC.

Through three of the four diffractions, the propositions have produced insight into elements of the artistic creative process to expose how interventions could play a role in enhancing procedures or dispositions. Priming and metacognition are both essential in the creative process and are intuitively pursued by the participants, regardless of domain. It is not the quest for novelty but the perception that an encounter, however remote, can be transformed into proto-assemblages, the building-blocks of a creative inquiry. Metacognition is interspersed within this process, much like the executive and salience networks gather combinations that collude with long term memory (curiosity) to form the inquiry. Insight is not exclusive to this phase; to varying degrees, reward impulses are a factor throughout the process.

Artistic research can involve revisiting past projects, which speaks to a thematic evolution of the creative journey. Ultimately, for many inquiries the principal creative decision-

making occurs during the pre-work phase. At that point, technique and experience are applied to execute the plan, responding to deviations or alterations as the inquiry progresses. As a significant finding from this diffraction, interventions are likely to be most applicable to the “pre-work” or “pause” phases, when the inquiry is more open to exteroceptive influences.

Question 1: Where Metacognition Occurs

How do pre-service arts educators and students of fine arts and neuroscience within an art-science collaborative respond to interventions predicated on the metacognition of creative processes?

Notwithstanding that an intervention before or during the creative process—even just discussion of one—will engage metacognitive thinking as participants try to make sense of the task, there is evidence that the selected activities offer opportunities for practitioners to diffract their own practice metacognitively. Applying the interventions within a learning context permitted mindful interrogation of creativity with participants who may already perform the desired outcomes intuitively.

The very process of compiling artist statements, journals, and interview responses inherently engenders some form of a posteriori metacognitive disposition in participants. Consequently, it becomes more challenging to detect their efficacy in the moment. Participants recalled some interventions more than others both through aided and unaided response: e.g., those raised in the interviews, such as the self-curated creative space. This recognition provoked thinking about priming; although choosing non-task related materials was puzzling for some participants, particularly for the scientists among the group, they generally affirmed that the images or materials could be disruptive and/or inspiring. While immersed in the work phase, however, full executive metacognition appears to be counter-intuitive and negatively disruptive.

Interventions may be most appropriate during specific phases: pre-, post-, and during pause cycles, to help navigate to a flow state or to debrief successful/unsuccessful strategies and procedures.

This raises the question of pedagogy: should all interventions related to the creative process contain a metacognitive component, or are some best done subliminally in the moment (as opposed to supraliminal priming) as an express means of disrupting/altering a phase in the creative process? Providing insight regarding possible strategies to revive or reset inquiry, with learners selecting and integrating themes as procedures into their creative routine (like self-curated priming), empowers their existing creative and technical capacity.

The participant groups were both dispositionally and autodidactically attuned to procedures that foster creativity, which may diminish the effect of the interventions. Nevertheless, the ability to find congruence and intersections regarding the propositions emerged from participant descriptions of their process, who enact by default the qualities inherent in the propositions. From this, I conclude that pedagogies related to exploring metacognitive dispositions as well as procedures may have merit, although for learners with less experience or skill.

Question 2: Priming

How does NsC research related to preparatory creative priming offer pedagogies and modes of learning for art education?

Connected to the first question, preparatory priming, especially task-related priming, was practiced by all participants: whether by walking and reflecting, walking and documenting, connecting to artist groups through social media, or researching a recent idea. This reinforces the idea that insight is frequently the product of procedures or routines rather than merely

happenstance. Just as an applied technique is refined over time, it becomes more automated in the brain, with the benefit of making more frequent connections more quickly but also the risk of ignoring more remote stimuli.

Of particular interest in the diffractions is the significance of material selection to artistic inquiry, to the extent that it might be considered for a priming pedagogy—for instance, exploring a variety of materials even prescriptively, to engage restriction. Equally interesting is participant use of past projects as self-curated priming or research material. Emery offers some insight into this practice:

I think it comes from a selfish place, mostly, honestly, like if it's something that I relate to, or an experience that I had ... but like the best way to create a project is basing it off of the things you know. (Emery, DART 499/631)

Bringing this concept forward into metacognition may be of use in art education and NsC regarding the role of long-term memory in ideation.

Glow Moment: *Désire* versus Expertise. Expertise extends beyond skill with materials and processes. Over time, some procedures become more automated due to acquired experience, thereby requiring less executive function (focus) to apply. Expertise also extends to refinement in problem-finding capacity, such as being able to shorten the cognitive distance and time required to identify, accept, or dismiss the potential of novel stimuli. While *désire* appears to align with innate curiosity, the metacognitive capacity to expand the elasticity of creative “mood” and/or transcend it with disciplined procedures or auto-pedagogies is worth exploring, particularly in art education.

How does revealing creativity operate when expertise is developing or operating in a medium or inquiry that is unfamiliar? Within domain-specific learning contexts, scaffolding

artistic choices within a limited range (for example, restriction in media used to apply a narrow colour palette, or requiring depth of field examples in a photography portfolio) can increase the probability of a satisfactory outcome and, owing to the limitations of the criteria, create knowledge that can be applied to future contexts. However, it is more challenging to address this question in sci-art contexts because, despite both domains approaching unfamiliar methods and processes, they do so from a standpoint of pre-established expertise. In this regard, evidence of creativity may require more metacognitive explanation through process journals or “scientist-artist” statements, as well as interventions oriented around priming, counterfactual thinking, and metaphor to reveal where the novelty or originality behind creativity lies.

Eva suggests that *désire* is found in expertise, and that part of developing expertise comes precisely through this intensity:

I think that if the curiosity and the passion is there, then the rest will come, especially with art or even with music. Like, practice makes perfect. ... 'Perfect' doesn't exist in the art world, but the more you practise, like, you don't need to necessarily be gifted to have a passion. You can just practise. (Eva, ARTE 432)

Question 3: Transdisciplinarity

How does collaborative investigation between art and science co-constitute transdisciplinary understanding?

In terms of pedagogies and procedures, there is sufficient congruence in terms of parallel stages of inquiry between art and science (see Dressler & Borrelli, 2018). Within this inquiry, differences between artists and scientists with respect to dispositions towards creativity were negligible, which facilitates collaboration. The development of priming and mindfulness activities may have generic pedagogical intention and effect, especially as a means of revealing

domain biases or possible points of effective collaboration. Some priming may need to be subsequently tailored to domain-specific contexts, especially when they are related to technique or context.

Arguably, however, there is benefit to maintaining a tension between domains to build in accountability and access the particular affordances each domain has to offer. Artist-scientists may move more fluidly between domains, and existing initiatives or programs may also develop through practice and time, bringing greater clarity to transdisciplinary procedures, pedagogies, and dispositions. In the interim, the diffracting of the two domains through each other via each negotiated ecology of practice offers positive disruption, novelty, and a genuine shared curiosity.

Transdisciplinarity does not necessitate *similarity*. Though there may be shared interests and objectives and parallel approaches to inquiry, it may be counterproductive to arrive at a formulaic, one-size-fits-all set of protocols. In fact, inherent in the various tensions generated and negotiated within each inquiry, and consequently within each assemblage, are the openings that allow for substantive, collaborative research to flourish. Within these spaces of exchange, there needs to be room for iterative, recursive, and nonlinear exploration, much like the research phase of domain-specific creative processes. The connection between collaborative sci-art initiatives and research into NsC may be to identify transdisciplinary dispositions rather than specific methods or procedures.

This diffraction reveals that each question offers insight into creativity: both its guideposts concerning process and its role in learning. The first question revealed the value of metacognition, but also how it needs to be suppressed or encouraged at different points during the creative arc to provide the necessary evaluative distance. Moreover, NsC's contentions

regarding memory and priming are clearly illustrated by participant content, opening pathways to a number of possible pedagogies in art education, some of which have been explored here.

As for the propositional framework, what also emerged from the diffraction was the understanding that the propositions are interdependent, to the point they could be paired differently and produce new and different insight. Although they have been arrayed in pairs, it is clear from the diffractions that a closer network is in operation. Just as there is a recursive loop between networks in the brain (Abraham, 2018; Beaty, 2020), the concepts behind the propositions in this study are interrelated; some became more active than others at different stages of the creative process. Furthermore, the individual concepts combine in different ways. Intensities and sensorial dispositions co-mingled during the discussion of materiality just as affinities connected with process, given the passion for the process itself felt by some participants. Similarly, the propositions can be reconfigured around the concepts of interoceptive and exteroceptive influence: process, affect and intensities align with interoceptive influence, and relationality, sensorial, and affinities align with exteroceptive influences.

Chapter 5: Insights and Possibilities

The previous chapters have described an organic process of diffractive movements entangled through a propositional framework: the reading-through of art education theory with NsC theory, the participation of students from both art education and art-sci/sci-art domains, and finally, the interventions inspired by NsC. The propositions reflect not only a pathway into exploring the research questions but also my own explorations into the nature of creativity and learning. Intensities/affinities, affect/sensorial, and process/relationality regarding creative work are dispositional for me, and yet in my experience in education, they seemed unnaturally truncated by disciplinary boundaries. Excitement regarding exploration, querying agency in the nonhuman and more-than-human, is shared across disciplines and domains, as is building those spaces of exchange and exploring interventions that develop metacognitive awareness.

Delving further into the application of those interventions and the diffractive process, in this chapter I discuss meaning-making: how pedagogies (matter and mattering) bring about productive differences that have impact, even as new meanings emerge. The first section of this chapter examines the interventions used in this study from the perspective of an art educator interested in pedagogies that prime for creativity. The second section looks at the implications of this research for art education and possible areas in which this research can be mobilized or expanded. In the third section, I explore the context of this study in the domains of art education theory and, to a lesser degree, NsC. The final section returns to questions I have raised in this inquiry, offering possible avenues for future research.

Glow Moments and Interventions

Transformed by site and insight, glow moments are revealed in diffractive findings

reshaping inquiry in elliptical and combinatorial ways through multiple diffractions. Nascent understandings provided by NsC research are an apt metaphor for the way they conjure immanence—an opportunity to add novel perspectives to refine or debunk beliefs and theories regarding a holistic understanding of creativity and determine if/how it can be influenced.

Having learners distinguish between effective task-related and non-task related priming materials allows them to conduct an introspective inventory that connects to their motivation. Similarly, envisioning an optimal work environment will achieve mindfulness around exteroceptive influences. Disruptive types of interventions engage similar introspection and extrospection, using restrictions (or prompts) in an aesthetic setting (see Garoian, 2001). For example, ROAM cards provided a way to disrupt and challenge learners to observe and respond differently. In another example beyond this study, a form of disruptive activity was conducted collaboratively in a museum setting among learners charged with locating artworks of their choice, predicated on a theme (Osler et al., 2022). A variant on priming/disruption is an exercise that forces connections between remote objects. I have used such an activity in other contexts with the premise that experiencing rarity allows for greater flexibility in divergent thinking contexts. Requiring connections where they are not apparent encourages play and exploration and, based on this inquiry's findings regarding materiality, provides an opportunity to combine this concept with a variety of materials instead of objects. Additionally, developing metacognition of counterfactual thinking strategies invites the learner to revisit the configuration of a problem and improve problem-finding capacity, also serving as a means of disrupting a block in the creative process.

The timing of interventions is important: their efficacy seems to be greatest when they relate to the preparatory (insight and research) phases. They could also be applied as restrictions to problem-finding to stimulate divergent thinking, as long as they increase the probability of

achieving or returning to a flow state. Similarly, the form of the interventions should be configured as exploratory exercises or play (i.e., non-task related), but with a reflective component to promote metacognition.

On the whole, interventions such as those used in this study can reference and highlight metacognitive dispositions that increase the probability for meaningful insight to occur. They are, however, able to provide a means of revisiting and introspectively interrogating a learner's process and provide optional processes, some of which can become productively habitual (combining task-related and non-task related priming materials). Moreover, they serve as entry points into the discussion of procedure and process, which serve learners with additional vocabulary for reflection, introspection, and sharing.

If the assumption that mindfully engaging in the creative process will alter its performance holds true, then pedagogies that reveal and develop these dispositions may improve problem-finding and creative flexibility. However, as creativity is subdivided into divergent and convergent thinking strategies, mindfulness may enhance the process or, by contrast, add a distractor to the process, unintentionally reducing capacity. Even the discourse around using interventions to alter creative behaviour results in metacognitive awareness of a process intended to enhance intuitive decision-making. This awareness may be construed as an interruption of flow—but these interventions are intended to increase the chances for flow to occur. It is the capacity to approximate flow through discipline that attunes the brain to problem-find more effectively. Therefore, decisions on the type and timing of pedagogies formed part of this inquiry, determining at what points in the creative process might pedagogies predicated on mindfulness enhance creative work. This study has shown that interventions at the problem-finding and research stages offer the greatest potential, for they are connected to metacognition.

Implications of the Study

This study was designed to interrogate creative thinking processes across disciplinary boundaries. The implications for educators are significant: in addition to developing transdisciplinary learning dispositions, pedagogies are already in the process of being reconfigured to promote greater neuroplasticity, particularly as education more equitably addresses neurodiversity. Artists, art educators, and scientists together respond and contribute to the breadth and depth of this research by developing and refining related pedagogies similar to Hardiman's (2012) "Brain Targeted Teaching™" in which the focus is on metacognitive, dispositional thinking. Such iterative, recursive, and transdisciplinary collaborative processes are reshaping and redirecting endeavours to advance applied strategies that promote a/effective, embodied divergent and convergent creative processes.

Expanding Perceptions

The ability to empower creative processes among learners offers access to intuitive, affective, and non-linear expression, a capacity present in the participants of this research made more accessible for all. Such diffractive questions query *how* and *why* the lived experience of an artistic practice matter, offering a dialogic model of interaction (Chappell et al., 2019; Gallagher, 2015) between artists and the myriad environmental, affective, and material stimuli they encounter. By combining these external-internal processes physically and metacognitively, I move contextual, situated learning to the probability of fruitful creative work, propagated as a pedagogic pivot beyond the scope of existing instrumentalist approaches that continue to focus on elements and principles of design (see Higgins, 2008). Expanding perceptions of creativity across domains is necessary; enabling accessibility to all learners through education can assist in breaking through limitations imposed by discipline-based balkanization.

Ultimately, art education theory need not be isolated from conventional understandings of research—for some researchers, it offers supplementary tools for sense-making, a visual code able to reveal additional insights that may not otherwise be available. The “making” component of participation in this study—student generation of ideas and responses to the interventions, along with the collaborative art-based projects produced across disciplinary boundaries—illuminates metacognitive awareness of their process in action and offers potential insights that extend beyond mere introspection alone.

Outwardly focused, this research is problem-oriented; its shared curiosities and investigative capacity elevate, along with its collaborating disciplines, the breadth and depth of an inquiry. By contrast, art education theory contributes to the conversation of creativity by revealing diffractive and qualitative relationships that appear within the creative act. Our predispositions to notice and respond are embedded in affect and values, which are in turn revealed through practice and reflection. The desire to create, the transition from intuition to ambiguity to insight and the attendant “reward impulse,” are attached in part to cognitive meaning-making. But like the networks in the brain, it incorporates potent visceral and emotive entanglements that together produce the thrill of creative enterprise and the transportive qualities of the flow state.

Entanglements and Tensions

Engaging in NsC informed learning by bringing outlying perspectives into domain specificity illuminates disciplinary blind spots and infuses plasticity into rigid epistemological frameworks. An aspect of diffraction is the understanding that passing materials or concepts through filters may change their behaviour or their direction. The tension between orientation (stability in thought and process) and disorientation (a state of ambiguity) resembles the

disruptive qualities that promote more provocative creative connections. Gray et al. (2021) assert that “disorientation is revealed as resembling feeling lost in space—no longer having a space in place—and in time—a temporalities-based framework that only really starts making sense once it has been brutally halted” (p. 216). For mastery to occur, more than single-domain expertise is required; collaboration elevates an inquiry as well as the participating disciplines. Troubling the uncertain or bewildering places where disciplines collide, mesh, or resist enables richer novel experiences that offer a meta-perspective to be much more attainable.

Confronting existing dynamics within an educational framework requires initiative and advocacy. Collaborative, experimental transdisciplinary initiatives operate as diffractive filters that query the ontologies of existent domain boundaries and probe broader, deeper, and more resonant understandings and values. Art, science, and other disciplines in crafted or spontaneous clusters are more resilient when approaching the boundaries and intersections of the uncertain, the imagined, and the (im)possible. Gray et al. (2021) suggest a clever compromise concerning modalities: “transversal minor practices (minor science, minor art, minor literature, minor philosophy, minoritarian becomings, etc.)” (p. 217) need to become infused with or at least coexist alongside conventional domain paradigms. On a meta-level, as institutional or domain doctrine diffracts the process in part or in moments, intra-acting with these “minor” modalities permits a more accurate situating of their pursuits and perspectives as they operate in the interstitial spaces of exchange.

Considering entanglements within an ecology formed through art-sci/sci-art collaboration, I turn to Gray et al. (2021), who suggest that the quest for transdisciplinarity may have unanticipated outcomes:

breaking through disciplinary barriers and finding, rather than Snow's third culture²⁶, the latitude to uncover multiple epistemic cultures that reside in-between conventional educational boundaries. Pedagogy needs to provoke the minds of learners to interpret and create by ... trespassing, hopping fences, and forging tangled interdisciplinary pathways across multiple disciplines. (p. 214)

Transformative Possibilities: Art Education and NsC Research

Art-sci/sci-art informs the potential of transdisciplinary connection and offers transformative possibilities for art education. On a theoretical level, conjoining art and science empowers both disciplines. Art education research invites more fluid and responsive (yet still rigorous) approaches to inquiry, congruent and complementary with the open curiosity found in exploratory scientific research. Just as "rarity" within a priming set will stimulate unanticipated connections, so too will art-science alliances furnish rich and surprising discoveries. On a practical level, by integrating NsC research within art education, a more holistic picture of learning and creating is formed, and pedagogies that have been intuitively configured can be affirmed, revised, or substituted. Additionally, examining NsC research in the lived experience of learning in art education provides useful feedback to art-science researchers as they refine or redirect their inquiry focus.

Engaging with ideas across disciplines may help both artists and scientists to attain further clarity around complex processes such as artistic creativity. While it seems intuitive that a linear approach to artmaking is anathema to creative freedom for an artist and learner, that is not

²⁶ C.P. Snow (1959/1990) contended that the arts and sciences have distinct epistemological cultures and that interdisciplinarity would require the establishment of a 'third' culture. See also Kelly (1998) and Vesna (2001).

the intention of this research. For art educators, mobilizing this research may point to additional pedagogies that will enable learners to enhance and refine their creative practice through more mindful, more intentional approaches.

While domains may offer differing modes of expressing creativity, there are more similarities than differences in interoceptive and exteroceptive interactions that influence creative thought. The implications for art education are to develop skills and dispositions enabling a breadth and depth of domain-specific decoding and encoding. Additionally, any intervention involving creativity will most likely occur during the encoding and ideation phase through priming, research, (generating and revising) preliminary sketches, or experimenting with new materials or techniques, which warrants a more exploratory combination of transdisciplinary creativity pedagogies and domain-specific learning.

Future Directions

Creativity in Art Education

One principal aim of this study was to offer a contemporary perspective of creativity from a diffractive perspective to contribute to a larger transdisciplinary discourse on creativity. A further aim was to reveal potential pedagogies for creative metacognition in learning contexts, especially art education. On a meta-level, there are possible congruences between the creative process as revealed in this study and the theoretical and methodological approaches contained in diffraction. Both unfold a coming together of agencies and materials to perform: seeking insight, difference, and the product of those differences. Within creativity, an insight is diffracted through materials and techniques into an assemblage to then co-constitute novel performativity in both the process and the resultant artifact. This potential aligns with the diffractive concept of “transcorporeal engagements, involving other bodily faculties than the mind” (Lenz Taguchi,

2012, p. 276). Establishing diffraction as a parallel structure or metaphor for creativity offers an opportunity to further unfold the embodied, *becoming* nature of the creative process, one that authentically incorporates a greater diversity of interoceptive and exteroceptive processes.

Pedagogies and Possibilities for Artistic Practice in Educational Contexts

Greater understanding of responses to both interoceptive and exteroceptive stimuli points towards possible pedagogies in artistic personal practice and learning contexts. Mindful selection and application of these practices at ideation and experimental stages of the creative sequence may serve to increase performance for various tasks, such as generating more resonant ideas, embracing novel material/media combinations, embracing unfamiliar techniques, and redirecting unfruitful progress. While these activities can occur intuitively in practice, mindfully applying them as pedagogies or activities may develop productive creative dispositions in learners.

For initial phases of the creative process, priming approaches may include but are not limited to

- self-curating priming materials such as image files
- activating long-term memory with non-task related content
- preparing the creative environment
- forcing connections between unrelated concepts
- researching contextual background
- revisiting past projects
- experimenting with/selecting techniques through prototypes.

As a project progresses past ideation, interoceptive stimuli include the artist's cognitive, emotional, and aesthetic response to progress work as aesthetic problems become resolved (or remain unresolved). Interoceptive dispositions reflect the idea of creativity as a state of *becoming*

(Chappell et al., 2019), an interdependent, dialogic, explorative event during which the artist, the environment, and the material are in a continuous state of transformation:

It requires us to pay attention to the way in which material bodies participate in the dialogue and pushes us to notice the voices of assemblages ... of human and non-human participants ... where the boundaries of the groups are dynamic and can shift, dissolve and be remade. (p. 299)

This recursive property of the creative process is predicated upon ongoing revealing and sustaining the creative problem; any initiative, intervention or pedagogy facilitates the intra-action of artist and inquiry. By approaching the problem of creativity through the metaphor of dialogue and entanglement, the artist and learner moves to a deeper metacognitive awareness of the multiple agencies involved in their own creative process.

Transdisciplinary Dispositions and Pedagogies

On a theoretical level, exploring art-sci/sci-art collaborations may empower both disciplines. On a practical level, integrating emergent findings of neuroscience concerning creativity as a subset of cognitive meaning-making and bringing this to bear on art education may enable revisiting a more holistic picture of both learning and creating, whereby pedagogies intuitively configured are affirmed, revised, and/or substituted.

Now that a variety of art-sci/sci-art programs have been established worldwide, it would be productive to compile a comparative analysis of current curricular and pedagogical practices in art-sci/sci-art initiatives. Such an analysis would offer a baseline of pedagogical approaches that arts educators could build upon as NsC expands its research scope. In particular, cultural differences regarding perceptions of creativity are the basis of mapping new pedagogical approaches, models, and modes of inquiry. As insights and contributions from NsC regarding

artistic creativity continue to unfold, there is possibility for collaboration with art education, especially in terms of refining both models of creativity and the interventions that are most helpful in effective priming and metacognitive dispositions.

Final Thoughts

I intend to build upon the structure and integrity of this inquiry, transposing neuroscience of creativity research into an arts context in education. As part of a recursive, iterative process, I am interested in building pedagogical partnerships with transdisciplinary educational initiatives similar to Canada's Convergence Initiative (<https://www.convergenceinitiative.org/>).

When considering this inquiry and my role in it, I have come to understand that, on a meta-level, I have diffracted my own curiosities and assumptions about creativity through NsC. Many of the findings here affirm insights I have experienced in my own artistic narrative rather than revealing new ones. What is true for the participants is palpably resonant for me as well, both as an artist and as an educator. I am convinced that this study is a departure point, strengthening the potential for new possibilities associated with a collaborative art-science inquiry, one which explores domain-specific creativity while collaboratively interrogating the epistemology of transdisciplinarity. Greater insight into dispositions, affect, and cognition and metacognition will illuminate pathways for both research and learning.

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Appendices

Appendix A

Participant Recruitment Letter (ARTE 432)

My name is Trish Osler, and I am a doctoral student working under the supervision of Dr. Anita Sinner in the Department of Art Education at Concordia University. I am contacting you because I am conducting a study that looks at perceptions of creative process in art education. I am currently seeking volunteers from Concordia University who have taken ARTE 432 as participants in this study.

Participation in this study involves sharing documentation of specific course activities involving creative work. It also involves participating in a conversation-style interview about the creative process. This interview may be held virtually or in-person. Participation would take no more than ninety minutes (with additional time for checking the transcript of our discussion).

I would like to assure you that the study has been reviewed and has received ethics clearance through Concordia University's Research Ethics Committee. If you are interested in participating, please contact me at trish.osler@concordia.ca . I will then send a confirmation email with an information and consent form to complete and provide you with further information concerning the process.

Thank you for taking the time to consider this opportunity.

Sincerely,

Trish Osler
PhD Candidate, Art Education
Faculty of Fine Art, Concordia University
1455 de Maisonneuve Blvd. W.,
Montreal, QC H3G 1M8
email: trish.osler@concordia.ca
tel. 416 452 1401

Participant Recruitment Letter (DART 499/631)

My name is Trish Osler, and I am a doctoral student working under the supervision of Dr. Anita Sinner in the Department of Art Education at Concordia University. I am contacting you because I am conducting a study that looks at the neuroscience of creativity, and in particular, perceptions of creative process in art education. I am currently seeking volunteers from the Convergence initiative at Concordia University who have taken DART 499/631 as participants in this study.

Participation involves sharing documentation of specific course activities involving creative work. It also involves participating in a conversation-style interview about the creative process. This interview may be held virtually or in-person. Participation would take no more than ninety minutes (with additional time for checking the transcript of our discussion).

I would like to assure you that the study has been reviewed and has received ethics clearance through Concordia University's Research Ethics Committee.

If you are interested in participating, please contact me at trish.osler@concordia.ca . I will then send a confirmation email with an information and consent form to complete and provide you with further information concerning the process.

Thank you for taking the time to consider this opportunity.

Sincerely,

Trish Osler

PhD Candidate, Art Education
Faculty of Fine Art, Concordia University
1455 de Maisonneuve Blvd. W.,
Montreal, QC H3G 1M8
email: trish.osler@concordia.ca
tel. 416 452 1401

INFORMATION AND CONSENT TO PARTICIPATE IN A RESEARCH STUDY

Study Title: Diffractively mapping artistic experience: transdisciplinary approaches to understanding the creative process in art education

Researcher: Trish Osler, PhD Candidate, Dept of Art Education, Concordia University

Researcher's Contact Information: 416.452.1401 trish.osler@concordia.ca

Faculty Supervisor: Dr. Anita Sinner, Dept. of Art Education, Concordia University

Faculty Supervisor's Contact Information: 514.848.2424 ext. 5199
anita.sinner@concordia.ca

Source of funding for the study: n/a

You are being invited to participate in the research study mentioned above. This form provides information about what participating would mean. Please read it carefully before deciding if you want to participate or not. If there is anything you do not understand, or if you want more information, please ask the researcher.

A. PURPOSE

The purpose of the research is to examine the creative experience of pre-service art educators and students in art-science collaborations. This research will investigate participant responses to course-based activities designed to foster dispositions which favour aesthetic creativity.

B. PROCEDURES

If you participate, you will be asked to share your ARTE 432 and Convergence DART 498 course assignments and activities and reflect on the process of art-science curriculum design.

First, your course materials will be documented (photographed) and you will be invited to an interview lasting no longer than ninety (90) minutes, which may be conducted virtually and which I will record audiovisually. Second, you will be asked to review and confirm the transcript of your interview. Third, you will be invited to review sections of the final written report, at your discretion. This last step is optional and may require an additional estimated 2 hours.

Documentation of course materials includes excerpts from journal entries or sketchbooks, group discussions or collaborative activities, including exhibition artworks and written materials.

In total, participating in this study will take approximately 3 hours (interview and member-checking).

C. RISKS AND BENEFITS

You might face certain risks by participating in this research. These risks include uncertainty or discomfort when answering questions. Please pass on any questions you do not wish to answer. You may stop the interview at any time, and you may withdraw participation in the study at any time without consequence.

You may or may not benefit personally from participating in the study. Potential benefits include contributing to a study about art-science and creativity. This research is not intended to benefit you personally.

D. CONFIDENTIALITY

I will gather the following information as part of this research:

- Photocopies or images of journal entries or sketchbooks related to course activities.
- Images or audiovisual recordings of individual and collaborative art activities.
- Transcripts of interviews.
- Project documentation from classroom activities, including virtual or real museum visits, exhibitions, individual and panel presentations.

I will not allow anyone to access your information. I will only use the information for the purposes of the research described in this form.

The information gathered will be coded, in this case it will be identified with a name that you select. You may choose to be known by your name or a pseudonym in the interview and the research study.

I accept that my name and the information I provide is identified.

I do not want my name to be included and prefer to use the following pseudonym:

_____.

All information gathered from you will be coded according to the name you select. That means the information will be identified by a code (name). As the sole researcher, I will have a list that links the code to your name. I will protect the information by securing all electronic data on a password protected cloud site or hard drive. Hard copy documentation such as field notes or images from a sketchbook will be secured in a locked space in my home office.

I intend to publish the results of the research. However, it will not be possible to identify you in the published results.

I accept that images of my artwork and the information I provide appear in publications of the results of the research.

Please do not publish my artwork as part of the results of the research.

I will destroy the information five years after the end of the study.

F. CONDITIONS OF PARTICIPATION

You do not have to participate in this research. It is purely your decision. If you do participate, you can stop at any time. You can also ask that the information you provided not be used, and your choice will be respected. If you decide that you don't want me to use your information, you must tell the researcher before July 31st, 2021.

There are no negative consequences for not participating, stopping in the middle, or asking me not to use your information.

G. PARTICIPANT'S DECLARATION

I have read and understood this form. I have had the chance to ask questions and any questions have been answered. I agree to participate in this research under the conditions described.

NAME (please print)

SIGNATURE

DATE

If you have questions about the scientific or scholarly aspects of this research, please contact me at: trish.osler@concordia.ca 416 452 1401. My contact information is also available

on page one. You may also contact my faculty supervisor, Dr. Anita Sinner at 514 848 2424 ext. 5199 anita.sinner@concordia.ca

If you have concerns about ethical issues in this research, please contact the Manager, Research Ethics, Concordia University, 514.848.2424 ex. 7481 or oor.ethics@concordia.ca.

Appendix D

Demographic Profile of Participants

Name / Pseudonym	Area of Study	ARTE 432	DART 499/631	Artistic Pursuits
Chanelle -Lize	Art Ed	✓		painting, illustration, textile
Chlöe	Art Ed	✓		multimedia, sustainable materials, natural inks/dyes
Coney	Art Ed	✓		painting, collage, digital design
Emmanuelle	Art Ed	✓		textile, 3-dimensional, multimedia
Eva	Art Ed	✓		multimedia painting
Felipe	Art Ed	✓		poetry, painting
Ghena	Art Ed	✓		narrative drawing, painting
Jane	Psychology/Art Ed	✓		street art, painting
Kamila	Art Ed	✓		multimedia painting
Kassandra	Art Ed	✓		multimedia, digital, beadwork, mask-making
Mon	Art Ed	✓		sequential art, comic design, illustration
Amanda	Human Genetics (Psych Epigenetics)		✓	dance, music, painting, drawing, garment design, mask-making
Antoine	Psychology (Music Cognition)		✓	music, sonic art, poetry
Emery	Intermedia Arts		✓	digital, AI, wearable art
Felix	Design		✓	multimedia fabrication, industrial design, woodcraft
Manami	Design		✓	digital, graphic design

Tallan	Neuroscience (Pharmacology)		✓	multimedia

Course-based Activities for Thesis Research

The following sample activities have been developed as a means of focusing student attention on interoceptive processes (mindfulness) and exteroceptive processes (priming). Contextually, the activities are centred around either generative creative tasks or aesthetic appreciation of a natural or curated environment.

Sample Activity 1: Supraliminal Priming

Objective: Self-curated priming

Essential Question: How does rarity in the selection of task-related and non-task-related priming materials influence the creative process?

Task: Creation of Image files – task-related vs. non-task related

Steps: Participants are given the following instructions:

Based on the creative task you've been assigned/selected, create an image file of ten artifacts which are directly related to your concept. Try to select a variety of images related to the categories of form, content, and context.

Now, select ten artifacts(images) which are compelling for you, but are completely unrelated to the task. Try to select a variety of images related to the categories of form, content, and context.

Post task:

Participants reflect on the following questions in a virtual visual journal:

- Which task-related images/artifacts did you gravitate to during the actual process?

- In what way were they more influential?
- Which non-task related images/artifacts did you look at frequently during your creative work?
- How did you respond to them?
- If you became stalled or stuck during the process, were any of the images useful in reframing your approach? If so, were they related to the task?

Sample Activity 2: Walking-with a curated aesthetic space

Objective: Mindfulness & Defamiliarization

Essential Question: How does consciously disrupting interactions with curated materials shape aesthetic response?

Task: Using ROAM cards* (Miles & Libersat, 2016) to ‘walk with’ a curated environment

Steps: Participants are given a set of ROAM cards designed to defamiliarize their progress through a curated environment, such as a museum space. They explore the space, virtually and/or in-person, recording their observations with written prompts and/or digital cameras.

Post task reflection:

In a visual journal, students reflect on the most significant or surprising discoveries they made. They also reflect on the overall process of virtually visiting a museum space.

- What was the experience of following the ROAM cards like for you? In which other educational contexts would this activity be useful?
- How might this experience influence the way you explore (curated) spaces in the future?
- Which objects did you discover that were the most interesting?
- What other wonderings do you have after this activity?

*ROAM cards contain instructions such as *“Walk quickly in the direction you’re facing. Look for something that’s hard to identify. Stop when you find it. Sketch or photograph the object.”*

Sample Activity 3: Curation of creative space – task-related/ non-task related

Objective: Aesthetic literacy and (curated) environmental priming

Essential Question: How does priming through an awareness of environment shape creative praxis and response?

Task: Considering the environment as a priming exercise

Steps: Participants are provided with the following provocation:

Imagining that you are designing a workspace for creative tasks, how might you configure the space? Consider all five senses as well as materials or artifacts which motivate you. Additionally, consider the materials you would select for light or sound sources, furnishings, equipment and materials or media. Finally, consider the proximity of this space to other people working on creative tasks.

Produce a visual depiction of the space (illustrations, photographic images) along with a brief description of no more than 100 words as the rationale for your key decisions and how they would enhance your creativity.

Post task reflection:

- How does this exercise reveal your beliefs about your creative process? Did anything surprise you?
- Do you feel that you may have left something out that should have been included?

Explain your responses in words and/or images.

Sample Activity 4: Communicating a complex idea through artistic expression

Objective: Aesthetic literacy (working with metaphor) and priming

Essential Questions: How does the development of metaphor operate in the communication of complex art or science processes?

Steps: Participants are required to select a process from an area of formal training or personal interest that would be considered complex for others and select a metaphor to simplify its explanation. For example, it could be a model of a scientific or artistic problem/inquiry. They must generate a metaphor for a non-expert audience (akin to Vivaldi demonstrating ‘The Four Seasons’ in classical music, or gamifying the progression of a virus), satisfying as many of the following criteria as possible:

Symbolic content- no linguistic (verbal or written) cues should be used (*exception – poetry)

Media selection - Media and/or materials must be re-purposed from their original intent (i.e., found object, appropriated images, sound mashups).

Multimodal experience - multiple senses should be considered.

Interactivity - The audience will be encouraged to *interact with* the metaphoric model, rather than operate as passive observers.

Participants will submit an electronic proposal which includes a 200-word rationale and sample images, video, sound, descriptions. The rationale must address choices related to all of the criteria.

Post task reflection:

Following peer and instructor feedback, participants will reflect on their model and consider the following prompts:

- Which criteria posed the greatest challenge?
- How did you reconcile multiple criteria in your final choices?
- What is the greatest challenge in simplifying a complex process?
- In what other contexts could you apply your learning through this exercise?

Sample Activity 5: Counterfactual Thinking

Objective: Assessing Alternatives

Essential Question: How does counterfactual thinking operate as a refocusing strategy?

Task: Participants are given a description of a problem requiring alternative solutions to produce a more favourable outcome or avoid an unfavourable one.

Steps: The processes of counterfactual thinking will be explained to participants. There are three stages of counterfactual thinking:

- Activating prior memories
- Inferring possible alternatives based on salience and effectiveness
- Adapting behaviour

Upward counterfactual thinking - *if I do this next time, things may be better*

Downward counterfactual thinking - *if this also happened, things could have been a lot worse*

Example: Going to a movie.

Activate prior memories - What happened in the past? *I went to the movies but did not enjoy the film at all.*

Infer possible alternatives - How could the outcome have been different by changing behaviour?

(Assuming a similar scenario will be encountered in the future).

‘Upward’ alternatives:

- *Choosing a different movie.*
- *Going with a different person.*
- *Discussing the movie with someone else.*
- *Reading reviews of the movie before going.*
- *Not going to the movies.*
- *Going to a different movie theatre showing the same movie.*
- *Filming a movie of my own.*
- *Going at a different time.*
- *Re-watching a movie that I do enjoy.*
- *Reading the book version of the movie before/after going.*

Determine **salience** versus **effectiveness**. Rate the alternatives based on their perceived effectiveness (*i.e.*, *it would achieve the desired outcome of avoiding a bad movie experience*) or salience (*it would increase the chances of enjoying a movie experience*). Whereas all salient choices will also be effective, not all effective choices are salient. Identify choices that are neither salient nor effective.

Add to the list. Brainstorm and select three effective but non-salient hypotheses.

Brainstorm three salient hypotheses. Consider which is harder to do? Which behaviour would you be most likely to select?

‘Downward’ counterfactual thinking:

- *At least, the movie was short.*
- *The movie theatre has the best popcorn in town.*
- *The movie theatre was not far from where I live.*
- *I went with a friend, so the rest of the evening was enjoyable.*
- *The movie theatre was not too cold.*
- *I like going out. If I had stayed home, I would have been bored.*

Add three other downward counterfactual alternatives.

Post task reflection: Visual Journal Response

Following class discussion, participants will reflect on counterfactual thinking, specifically how they might adapt behaviour based on the following prompts:

- Which upward assertion would you select? Which downward alternative would you most likely employ?
- How could counterfactual thinking be useful on more complex tasks, such as those involving creative components?
- What are the limits of counterfactual thinking?

Student Sample ROAM card

<p>Walk 17 steps. Close your eyes. Turn around. Open your eyes. Look for something red. Sketch/photograph the object.</p>	<p>Turn left. Walk 12 steps. Look for something tiny. Sketch/photograph the object.</p>	<p>Walk slowly in a circle. Look for something boring. Sketch/photograph the object.</p>	<p>Walk quickly in the direction you're facing. Look for something that's hard to identify. Stop when you find it. Sketch/photograph the object.</p>
<p>Turn right. Walk 4 steps. Look for something shiny. Sketch/photograph the object.</p>	<p>Turn around. Choose a number between 16 and 23. Walk that number of steps. Look for something fascinating. Sketch/photograph the object.</p>	<p>Turn left. Slowly walk backwards ensuring that you do so safely. Walk any number of steps less than 10. Look for something smooth or rough. Sketch/photograph the object.</p>	<p>Turn right. Take two large steps forward. Turn left. Look up Sketch/photograph the object you notice first.</p>

Guiding Questions for Semi-Structured Interviews

What type of creative work do you do?

How do you prepare for a large creative project?

Have you ever conducted research in preparation for a creative project? If so, how did you accomplish this process?

What types of creative tasks/problems are you drawn to? Why do you think that is?

Have you ever begun a creative project, only to have it shift to an entirely different problem?

Recalling a project that you have completed, how would describe the steps in your creative process?

How would you describe creative inspiration?

Where do you find inspiration when you need it? /How do you derive inspiration? /What inspires you?

Can you describe a significant 'aha' moment in terms of your creative practice?

How much does your environment affect your sense of creativity? In what ways?

How important is it to be around other working artists/creative people while you are doing creative work? Why do you think that is?



CERTIFICATION OF ETHICAL ACCEPTABILITY
FOR RESEARCH INVOLVING HUMAN SUBJECTS

Name of Applicant: Patricia Osler

Department: Faculty of Fine Arts\Art Education

Agency: N/A

Title of Project: Diffractively mapping artistic experience:
transdisciplinary approaches to understanding the
creative process in art education

Certification Number: 30013001

Valid From: November 03, 2022 To: November 02, 2023

The members of the University Human Research Ethics Committee have examined the application for a grant to support the above-named project, and consider the experimental procedures, as outlined by the applicant, to be acceptable on ethical grounds for research involving human subjects.

A handwritten signature in black ink, appearing to be "David Waddington", followed by a horizontal line.

Dr. David Waddington, Chair, University Human Research Ethics Committee