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Emergences: Towards a Cognitive Affective Model for Creativity in the Arts

Nigel McLoughlin

Creativity is defined as the production of something innovative or novel that is adjudged to be an appropriate or useful addition to some domain of endeavour. Within that definition, creativity may be thought of as existing in several different manifestations: it is an inherent set of traits in the person; it is the process of generating the innovation or artefact; it is a quality of the actual artefact that is made; it is the result of the judgment of those in power who deem it to be creative; and it is the addition that the artefact makes to the cultural definition of creativity within the domain of endeavour[1]. This should alert us to the fact that what we call creativity it actually a complex compound of processes which are related to culture, power and social processes, and genetic factors, as well as cognitive and embodied processes. These cannot be cleanly separated from each other.

Any cognitive process involved in the generation of a creative output will include biases and predispositions which are culturally acquired and which will direct the individual’s thinking towards one kind of output more than another. This may be illustrated in cultures where connection to a tradition is especially valued. In such conditions creative individuals are less likely to produce outputs that radically depart from or challenge the domain within which the work is produced, because such outputs are less likely to be seen as creative. In other words, they may be adjudged novel, but not useful or appropriate. In more permissive cultures, radical departure and challenge are encouraged and so the cognitive processes of individuals working within those cultures may make more use of strategies such as remote association and divergent thinking.

Because of this, attempts at satisfactorily defining creativity in order to measure it are often fraught with difficulties, but researchers have generally settled on two criteria, novelty and appropriateness. However, if one focuses the definition on the creative product, then there is the problem of external judgment, and who undertakes that judgment, when, and under what conditions. If one focuses on the process by which novel and appropriate ideas or artefacts are generated within the individual, one is dependent on the individual’s ability to judge the worth of their own production, since the process may be defined as any course of action which produces the novel and appropriate artefact. For this reason, in what follows I focus on the production of metaphors in the creative arts, because while the judgment of appropriateness is subjective to the individual artist, and the judgment of novelty still dependent on their knowledge of their field, one can assume that experienced artists are qualified and able to judge such outputs. The judgment of experienced practitioners has been referred to as the 'gold standard' in the consensual assessment technique for measuring creativity in relation to poetry and visual art[2]

In terms of metaphor production, the initial generation of metaphor tends to happen by insight. It is apparently spontaneous and unconscious, with the work of selecting between metaphors, and improving on them occurring after they come into consciousness and subject to attentional and analytic thought processes. This chapter will outline a possible model to account for the initial subconscious phase of metaphor generation, drawing on the current theories and evidence from cognitive science and neuroscience, in order to understand both the cognitive aspects of insight in metaphor generation, while also accounting for the emotional aspects of the process of making creative art, and the associated reward experienced by the artist in making the artefact. Because I am a practicing poet, most of my examples will be drawn from that discipline.

In her tripartite division of creativity into combinatorial, exploratory and transformational creativity, Margaret Boden [3] asserts that poetic imagery is a form of combinational creativity that generates a form of statistical surprise. Good imagery surprises because of its aesthetic difference from the norm in terms of linguistic expression. In this model, new variations on a poetic form, such as tailed sonnets, are classified as exploratory creativity, because new structures have been created using existing rules through a process of exploring the boundaries of the current form. Her third type, transformational creativity relates to paradigmatic change through the creation of structures or versions of a system that were previously thought impossible. One might relate this to the invention of new forms of poetry, but also perhaps to the creation of images and metaphors which are very surreal, extremely counter-intuitive, or impossiblist in some way. These types may also occur in concert or in combination to produce a new artefact.

Neuroscience has begun to investigate what happens during the creative process, and while this is useful to a point, we need to be careful in the conclusions we draw. All of the brain is active all of the time, and brain imaging techniques tend to work by subtraction, so they miss diffuse activation because it gets averaged out, and it is often not possible to say for certain whether activation is excitatory or inhibitory. That said, it is possible to combine neuroscientific evidence with other neuropsychological evidence, and evidence from cognitive psychology, in order to generate workable (and testable) hypotheses.

For example, Carlsson et al[4] showed that highly creative individuals tended to show bilateral activation in the frontal lobes while less creative individuals showed left-lateralised activation when engaged in creative tasks. This supports the view that the right frontal lobe is more involved in non-verbal representations while the left may exert control and evaluative functions. Both of these are necessary for truly creative endeavours. Reverberi et al[5] found that patients with prefrontal cortex damage performed better than healthy individuals in solving insight problems. This evidence can be taken to show that inhibition of frontal lobe processes can enhance creative thinking through the removal of online monitoring and evaluation processes. So how does this square with the Carlsson et al study? It may be that relatively increased activation of the right frontal areas could occur either through normal processing modes which balance the left (and so make it much less dominant) or, as Reverberi et al suggest, through damage to mechanisms that limit the response space, which tend to be more left lateralised. Carlsson et al also found a negative correlation between divergent thinking performance and activation in frontal regions in one of their experimental tasks. This might indicate that lowering activation in frontal lobes frees up divergent thinking processes by opening up the response space through thought processes becoming less directed and allowing a more diffuse activation pattern and a more freely associative thought structure. Or, because similar results have been found with regard to intelligence more generally[6], it might indicate that those who perform better at divergent thinking tasks use these cerebral networks more efficiently, with lower energy demands[7].

Frontal Lobes and Disinhibition

The prefrontal cortex can be seen as actively controlling access to concepts and experiences stored in other areas of the brain and making these available to working memory and thereby making them available for conscious attention[8]. Dietrich[9] points out that the prefrontal cortex is also been shown to be active in representations of belief systems and cultural values, and as such the material made available for the task may be selected at least in part by a mechanism that allows previous experiences, cultural norms, expectations and biases, to constrain the search for relevant material.[10] These may be partly responsible for constructing the biases which act to narrow down the response spaces that Reverberi et al referred to, by inhibiting what is culturally unacceptable or not valuable, or areas which are assumed to be irrelevant or inappropriate to the task.

Such biases can be problematic for generating a creative response since they may well lead to what is often referred to as 'satisficing', or producing a response that we know will satisfy the conditions required but may not be truly innovative. Good examples of this are to be found in the design on the first railway carriages, which bore striking resemblance to horse drawn stage coaches, including having the conductors sit outside, or the fact that when most people are asked to draw aliens they tend to be bipedal and symmetrical This is taken to result from starting with typical category examples, which are supported by episodic retrieval processes, or analysis of features[11]. Instructions to focus on abstract qualities such as 'life support' or 'nutrition mechanisms' tend to produce more novel examples, as does introducing rules which prevent the use of most readily accessible solutions and which open up the problem space[12].

This suggests that if the prefrontal functions were suspended, as they are when dreaming, daydreaming or in certain altered states of consciousness, then the search for material may take longer because it is unconstrained but the chances of a more truly innovative outcome would be increased. Martindale[13] suggested just such a mechanism whereby creative people are capable of entering a different mental state that is conducive to creativity. He describes this state as being characterised by a lower level of cortical arousal in the frontal lobes than normal[14]. This means that the activation is more diffuse and widespread in the brain, because the normal frontal processes that tend to inhibit this widespread activation in order to focus thought, have themselves been inhibited. This creates an environment where there is less inhibition of remote associative thought, thereby generating more novelty and an increased chance of new and appropriate associations. This is the basis of the disinhibition hypothesis. In what Csikszentmihalyi[15] describes as 'flow', the focus is internal, utterly consumed by the task, and awareness of the external diminishes. The creative individual is absorbed in a sufficiently challenging task, and is enjoying the task for the reward that it brings through the challenge of doing it. This too is a mental state that may be induced by inhibition of frontal processes[16].

A mechanism connected to the norepinephrine system in the brain has been proposed whereby disinhibition can happen. The frontal area responsible has been identified as the dorsolateral prefrontal cortex. From here there are connections in the brain that modulate the locus coeruleus, where norepinephrine levels are regulated. The locus coeruleus drives norepinephrine production in two different ways: It has a tonic role, which constantly produces a certain level of norepinephrine, and a phasic or transitory role, which can increase alertness by temporarily increasing norepinephrine production. Activation in the dorsolateral prefrontal cortex increases production and therefore attention by acting to stimulate the locus coeruleus[17]. Heilman et al[18] suggest that this increases the signal-to-noise ratio by narrowing the variety of concepts accessed. Decreasing activation in the dorsolateral prefrontal cortex can act to decrease stimulation of the locus coeruleus and thereby decrease norepinephrine production and decrease attentional focus[19] and they argue that decreasing levels of norepinephrine can lead to the discovery of novel relationships[20]. Heilman et al also suggest that creative people may store extensive specialised knowledge in the temporo-parietal regions; and they may have better ability to frontally modulate norepinephrine levels through the frontal locus coeruleus pathways[21] thereby creating a state where there is reduced signal-to-noise, and access to a wider network of concepts is possible. The dopamine system may also play an important role. Flaherty[22] suggests that one possible reason why dopamine antagonists suppress creativity is that dopamine promotes voluntary pursuit of goals and inhibits behaviours that might interfere with that pursuit. It is unsurprising that short phasic activation patterns in the dopamine neurons have also been found in relation to reward[23]. Essentially, one would expect reward and goal pursuit systems to be linked because expectation of reward would drive goal directed behavior to achieve it. However, increases in dopamine levels cause external focus and alertness, while decreased levels favour a more introspective mode of thought[24]. It is possible that these two systems may act in concert, to promote defocused attention and introspective thought, task motivation, and also external focus for more convergent processes, as well as to induce the mental states Martindale and Csikszentmihalyi describe.

Neurds and Nodes

One of the more recent models to explain how creativity can emerge from neural representations has been proposed by Gabora & Ranjan[25]. They outline a mechanism based on distributed but co-activating neural cliques and 'neurds', which encode non-prototypical but related aspects of a concept. This model is based on two qualities of the neural storage system for information in the brain. Firstly, memories are encoded through activation of neurons that are maximally sensitive to small ranges of basic features called microfeatures. Each neuron responds best to very low-level basic information such as a particular pitch or orientation. Each neuron is 'tuned' to respond best to this one particular microfeature, but they also respond to a lesser degree to a variety of microfeatures that are close to their most favoured one. Likewise, that neuron's neighbours, which are maximally tuned to slightly different frequencies or orientations, will also respond to some degree to their neighbour neuron's favoured tuning point. This means that representations in memory are distributed over many cells and that there is a certain amount of redundancy in the system, so that if one neuron dies, information is not lost. Neurons also get engaged in different capacities by being activated to different degrees by different stimuli that contain features close to, or exactly matching their tuning point. This means that they are capable of forming points of overlap between the representations of different stimuli and concepts[26].

Secondly, memory is 'content addressable'. There is a consistent relationship between the conceptual content to be encoded and the pattern of activated neurons that represent it in the brain. Because the network contains some redundancy and noise, memory is never retrieved exactly as it was encoded, because it will be subtly affected by all the experiences that happened between its original encoding, previous re-activations and its subsequent re-activations. The meaning of a representation is also subtly influenced by other concepts that activate networks of neurons that include some of the same neurons as the original representation does. This explains why memory can be both generally reliable but also unreliable in terms of detailed recall[27].

For Gabora and Ranjan, creativity occurs by a mechanism which echoes Koestler's description of a 'bisociation' of 'two different matrices of thought'[28], whereby two different concepts, linked to different association contexts are activated simultaneously through the commonalities between them, and this initial idea is then passed to the more convergent processes of 'effortful' creativity. In the generative phase, they assert, cross-talk between the neurons can be constrained by a centred radial basal function in which activation spreads out a certain width in all dimensions. Spiky activations have small widths and high activations at the centre, while flat activations have large spread and relatively low activations across the spread. As they point out[29], this idea of flatter and spikier activations is in line with the theory posited by Mednik in 1962[30], whereby flatter activational hierarchies afford greater remote association and thereby promote creativity, while spiky activations promote more focused thought through fewer potential associations between only highly activated and therefore highly salient representations. As Gabora and Ranjan posit, this might favour explicit information and the identification of causal relationships for example, while the flatter hierarchies may favour implicit information. The majority of the time, in directed thought, many neurds are excluded from assembles of activated cells but in associative thought more neurds can be brought into play, enabling access to more non-prototypical aspects, allowing thoughts to become more far ranging and quickly ranged over[31].

Martindale[32] has developed a similar model, which describes a set of nodes in varying states of activation, although he proposes that the most activated nodes are the focus of attention while the less activated nodes may be in the attentional periphery. These nodes exhibit a pattern of excitatory or inhibitory connection and exhibit sigmoidal activation which progresses towards an asymptotic maximum. These are subject to learning mechanisms such as Hebbian learning (through mutual activation) and inhibitory learning. These nodes occur in a number of environments through their presence in various modular structures within the brain[33]. Martindale uses this model to explain the aesthetic pleasure and displeasure experienced through a number of aesthetic effects.

Martindale illustrates the process using an example drawn from music where he shows how musical consonance may operate through nodes which reinforce each other in activation networks because they activate notes in harmonic relation. Some of the frequencies of one note are also activated by the presence of another note, thereby increasing overall activation. Musical dissonance, on the other hand, is thought to result from nodes which are in inhibitory relation because they are near neighbours in terms of the pitch to which they best respond. In order for pitch to be sharply perceived, inhibitory connections exist between near neighbours so that the note can stand out. Dissonance results from mutual inhibition of the neurons in the neural network that respond to frequencies which are too close together[34]. In this model, activation is inherently pleasurable while inhibition is inherently displeasurable. In a similar way, alliteration causes fatigue through repeated activation of the same nodes if it occurs too often, and this is perceived as displeasurable, but if it occurs far enough apart then it can cause repeated activation after refractory periods have ended and so be pleasurable. The same is true for rhyme. Meaningfulness is pleasurable for the same reason that gestalt figures are pleasureable: they increase overall activation by activating more nodes within the system, and metaphor activates more nodes through remote association, and therefore 'original' metaphors are perceived as more aesthetically pleasurable[35]. Pleasurable in this sense must be linked in some way to the brain's evaluative systems which are discussed below.

Pleasure, Reward and Affect

The research into reward has shown that both the expectation of a reward and the anticipated size of the reward can be represented in the brain through learning from prior reward situations[36] and that these representations may be encoded in dorsal basal ganglia circuitry[37], and the dorsolateral prefrontal cortex and striatum[38]. Research also indicates that we make judgements on complex stimuli such as music in relation to three axes of representation: we appear to represent how pleasing or rewarding something is; how active something is (often in terms of speed and unpredictability); and how potent something is (often qualitatively expressed in terms of strength, vigour and boldness)[39]. This effect would appear to cross culture and expertise levels and constitutes a very visceral way of internally representing and evaluating complex stimuli[40]. These three factors may well map onto neurophysiological systems related to reward, threat perception and uncertainty calculation. The reward system encodes pleasurability, threat encodes size, strength or danger; and the uncertainty system deals with movement and predictabiity.

Similar systems have also been described by Damasio[41] in his somatic marker hypothesis and can be connected to what Damasio calls the 'as if body loop'. This representationally combines the emotional and decision making processes of the brain by forming a feedback loop connected to the body's physiological resonse mechanisms which operate at both conscious and unconscious levels. This is partly what we refer to as gut feeling and the theory is that we 'feel' emotionally (and in a vestigial sense physically) the potential effects for us of a set of current or future circumstances in the real world[42] in order to assess the potential reward or punishment that might follow. This system may also be involved in generating empathic responses[43] and other researchers have suggested the involvement of these systems in the ways that we perceive and evaluate art[44]. It only requires a small extension of the imagination to speculate that such processes may also be responsible at least in part for matching creative outcomes generated against the representation of what is intended to be created. A sucessful match might well activate reward systems and enter conscious awareness through the processes proposed by Martindale along with a concurrent release of dopamine sufficient to promote the activation responsible into attentional focus[45].

Towards a Cognitive Affective Model

So given the evidence for how these systems operate, what might a cognitive affective model of creative insight which sets out to integrate these systems look like? And how might it achieve insight through the process that has been referred to in the study of creativity since Wallas[46] as incubation? If the supervisory and directing processes of the prefrontal cortex are deactivated, it is much more likely that the processes of thought will be unconscious, since there is no active use of material in working memory. Without engagement of working memory, thoughts tend to make it to consciousness through a competitive spreading activation model, which may be thought of in terms of neurons becoming synchronised as activation spreads to other neurons with which they share strong connections, until a certain critical level of activation is passed and the activation passes the threshold at which it becomes conscious[47]. Therefore, one would expect only some very salient output to suddenly become conscious in the way that we experience it in insight.

What is immediately salient to an expert will often be missed by the novice, however. Expertise may be defined as the internalisation of a set of skills and practices to such an extent that they can proceed without conscious awareness. Sometimes, it might prove very difficult for the expert to articulate the process when asked. This is because these processes now form part of the expert's implicit system. The explicit system requires working memory, and is capable of processing about four chunks of information at a time. The implicit system is not limited in the same way with regard to the capacity of information it is capable of handling[48]. Consider for example, coin dealers who specialise in gold sovereigns. A dealer can often spot a fake coin very quickly. In order to do so, they are using internalised information regarding the coin's colour, weight, feel, sound, and often more explicit information such as impossible year and mint mark combinations. The decision is often instantaneous and the exact reason is sometimes difficult to articulate, but is often described in terms of something not feeling right or something 'off' about the coin that attracts their attention. Novice coin collectors tend to resort to scales, calipers, neodymium magnets, jeweller's eyeglasses, catalogues, and other such aids, until they have handled enough of the coin to be confident and comfortable, until they have internalised the sensory skills and explicit knowledge into the implicit system. A similar process happens when we learn to drive. We depend very much on the explicit system at first, we are conscious of having to clutch, change gear, and use 'mirror, signal, manoeuvre' until we internalise the skill-set.

Then driving becomes much less effortful, and we are largely unconscious of the individual operations we perform when we drive, until something unusual happens and we are alerted to it. This may be thought of as statistical surprise, because something unexpected has cropped up, and that immediately engages the attentional focus.

There is evidence that thought processes related to goal pursuit can operate outside awareness[49]. What happens unconsciously may be thought of in the following terms: there is a neural representation of the problem, there is a neural representation of the conditions which a solution must fill and or might fill, and there is a neural representation of the anticipated rewards attached to the achievement of the goal state. The process is about finding a neural representation of the conditions that will change the problem as represented into something that closely matches the goal, perhaps using the goal state to provide some constraint on the associative processes involved[50]. When this happens, the reward circuits are activated; and there may also be an activation of dopamine-based reward systems[51] that are sufficient to promote the mental activity that caused the release to conscious awareness[52]. At that point we suddenly see the solution. This might be a workable theory for insight problems, but what about the generation of works of art? In the arts we do not have clearly defined problems; we often do not have any clear idea what the solution to our ill-defined problem might be. Even so, the arts do have a set of internalised practices and skills which are implicit in that they are acquired through the act of practice rather than consciously learned, are often difficult to articulate or describe, but which form part of the expert artist's practice nonetheless. So, what kind of representation might we be talking about in this instance?

In their concluding remarks, Gabora and Ranjan[53] admit that the model, good as it is, is incomplete because it does not explain the role of motivation or the emotions. However, since they assert that in 'a situation that is relevant to multiple representations, they merge together'[54] because of the mutual activation of the neural commonalities, or cross-talk, between them, one could move up a level from the neural representations to the level of mental spaces, which can be thought of as fleeting representations of images and concepts encoded in the way Gabora and Ranjan suggest. Merging of multiple representations through situational connection in this sense suggests a form of conceptual blending[55] and conceptual combination has been recognised as an important part of the creative process, especially in models such as Geneplore[56], while Shaughnessy and Trimingham observe the blending of ideas through practice in this volume. Gabora and Ranjan's ideas may, in turn, explain how input spaces are linked at a neuronal level in a blend. Neuronal representations of emotions can be envisaged as consisting of the same type of representations as memory in Gabora and Ranjan's model. The microfeatures in this case may be related to activation of neurons related to physiological features, as in Damasio's 'as if body loop', and these too will be tuned in the same way to respond to not just a single microfeature, but variably to a range of them. Considering that concepts can have an 'emotional valence' through their linkages with the physiological and emotional memories they evoke, as well as their episodic memory, it is credible that separate representations of emotionally loaded images can also be merged or blended through the 'cross-talk' of their common emotional neural activation patterns. By a further extension, one might posit that at a cultural level, symbols could operate through many individuals learning to attach the same values, and associative or metaphoric qualities, to certain culturally prevalent concepts, which are represented and linked similarly in many individuals.

Conceptual blending theory allows us to understand a wide range of conceptual phenomena such as jokes, counterfactual ideas, and metaphors, in terms of mappings between mental spaces, which allow emergences of novel structure and connections at the conceptual level. Mental spaces are conceived as temporary representational structures constructed by the participants in a language act to represent perceived or imagined situations in the past, present or future. Fauconnier and Turner describe four spaces: the two input spaces of the source and the target; a generic space, which represents the abstract commonalities between the two input spaces; and a blend space. The two input spaces contain specific features. If we extend this beyond language acts, and apply it to any conceptual representation in the mind, then in the neuropsychological terms discussed earlier, these may be thought of as arrays of activated neurons that encode the stored features of the two input spaces in memory. The generic space contains abstract features common to the two input spaces, which may be thought of as representing the activated arrays from the two sets of input features which are common to both. The blend space contains a compression of the common features, and also contains emergent structure from the specific features. These may be thought of in terms of additional activation of other neuronal arrays, through spreading activation from the original input spaces and the representation of common features through the associative system of the brain, which produces activation not originally present in either original 'input' array but which is strongly associated with their combination. Line and Per Aage Brandt[57] further developed the notion of mental spaces to include a mechanism for signification. Their approach combines conceptual metaphor theory and conceptual blending theory with cognitive semiotics with particular regard to metaphor. This affords the addition of a semiotic space that allows the conceptual blend to accrue meaning as a sign. One might suggest that this represents the activation of semantic and cultural associations of the image or blend in neuropsychological terms. Brandt and Brandt's version of blending includes a mechanism which supports the directionality of the metaphor in terms of target and source. It also states that the model be similarly applied in receiver and originator. This is useful for our purposes, because the creative individual is the originator of the metaphor, but also its first receiver, because they must attempt to understand the metaphor they create before communicating it to others.

By combining what these several systems tell us about how the brain may represent concepts and how those cognitive acts and representations might interact with the physiological, emotional and affective systems of the brain, I propose the following cognitive affective model, represented diagrammatically in figure 1, which seems to me to logically emerge from the research previously discussed and which is capable of describing an integrated mechanism whereby the separate systems may combine to produce complex artistic creative output. In his model of the neuroscience of creativity, Dietrich[58] separates insights according to how they may be classified as arising from two different processing modes (deliberate and spontaneous) and two different knowledge domains (cognitive and emotional). This gives four possibilities: deliberate cognitive, deliberate emotional, spontaneous cognitive, and spontaneous emotional, depending on whether the insight is produced by conscious or unconscious thought processes, and whether the insight itself has a cognitive or emotional manifestation. The model I propose suggests an integrated blending mechanism, by which spontaneous emotional insight might arise, manifested in an appropriate representative symbol or objective correlative, with regard to representational and verbal art, in effect creating both spontaneous cognitive and spontaneous emotional insight at the same time. The poet's problem is solved, as both the objective correlative and its appropriate emotion are realised.

The model is speculative of course, but if writers can't speculate on how the creative process works, well, who can:

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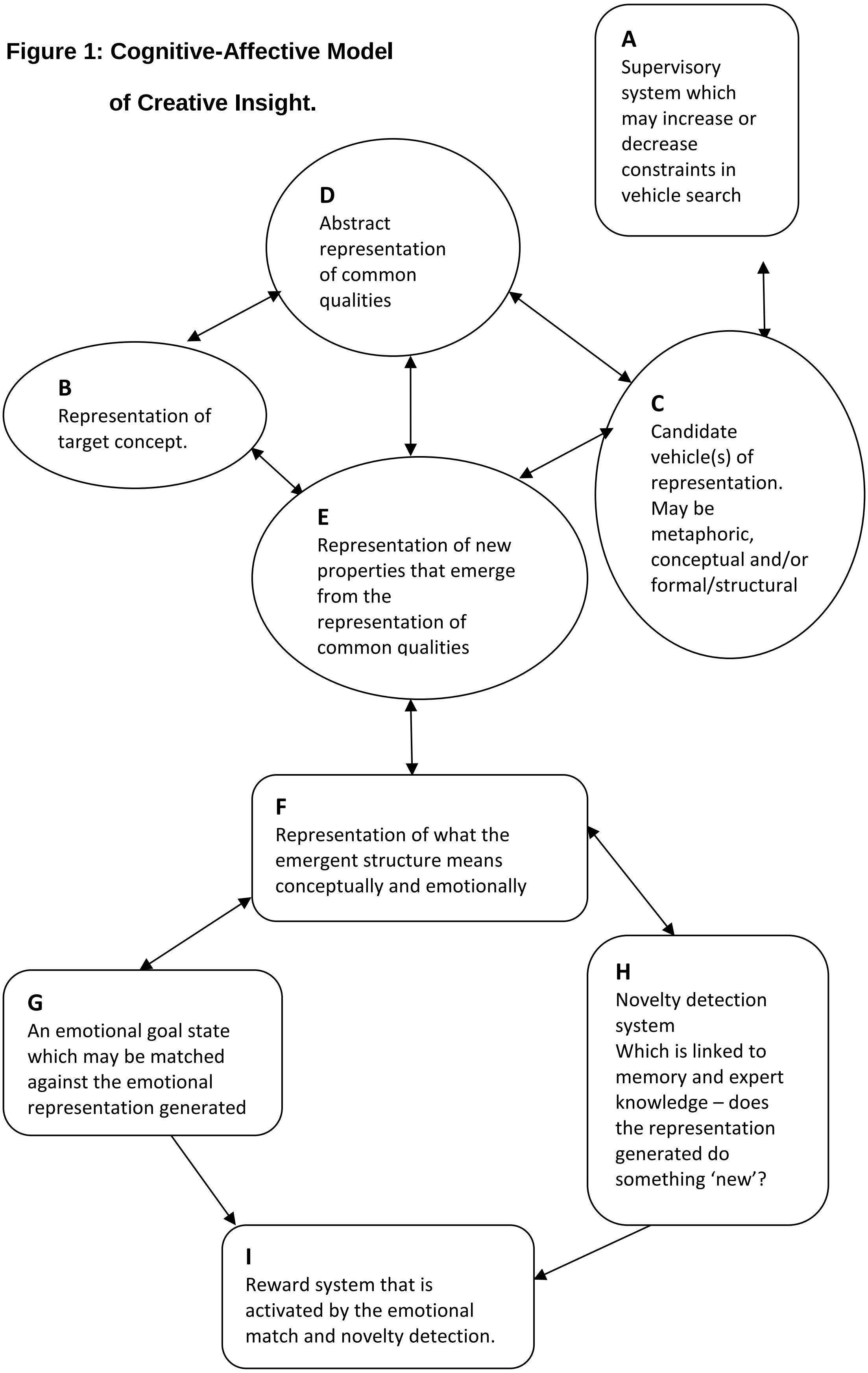
Figure 1: Cognitive-Affective Model of Creative Insight.



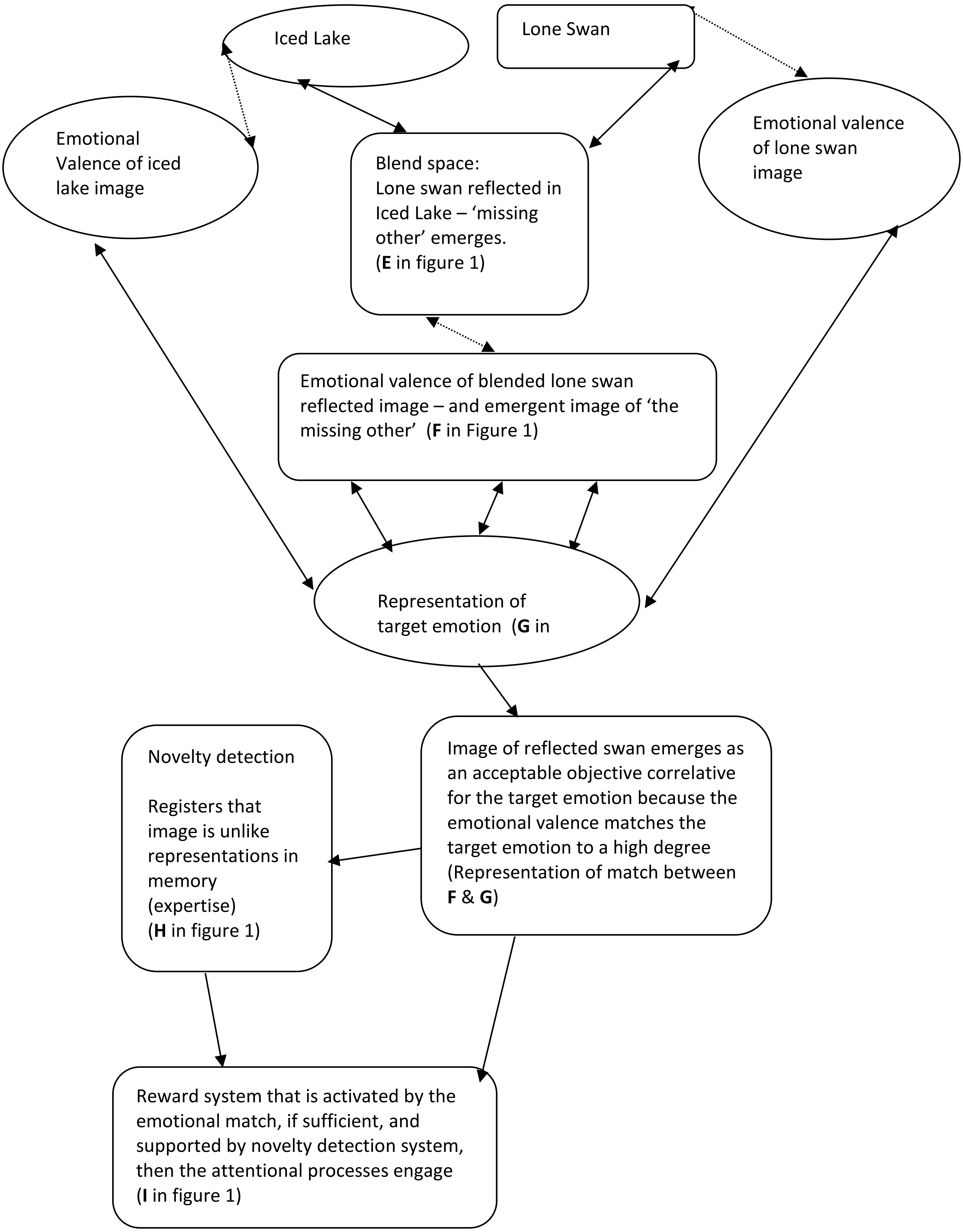
Say one is trying to write a poem in order to convey to the reader an emotional state. Take, for example, a poem on the death of a loved one. In order to get across what one feels about the death, one needs one or more objective correlatives[59], a set of images that will evoke in the reader the desired emotional response, so they feel what you feel – the set of emotions you intend to convey. The process of writing involves searching for appropriate vehicles that will convey aspects of the complex emotional response, and that search is modulated by frontal mechanisms (A) that can focus in or open up the problem space, so that suitable representations of the necessary vehicles are generated. This process can either be conscious, thinking through the problem methodically, or it might be much more unconscious and involve switching between the two different modes of thought, through the disinhibition mechanism discussed earlier. Given that there can be representations of emotional states encoded in the brain in vestigial form as Damasio proposes, which allow us to represent these states without the need to fully experience them, and given that these emotional representations may be matched against the emotional representations associated with, or engendered by novel images which can be created by remote associative mechanisms, this provides a means to internally and unconsciously test how well the image may stand for the emotion through increases in activation of neuron groups which are common to both the novel (source) and the target emotional representations. This suggests that we might mentally try out images (C) against the representations of loneliness, grief, or other connected concepts (B) to see if they can be mapped onto each other through the abstract representation (D), in effect carrying out a series of blends, where the level of activation in the generic space, which encodes commonality, indicates the level of fit with the target emotional valence. The novel and the target representations act as input spaces, in blending theory terms. A metaphoric match occurs where there is the best-fit from the candidate novel structure with the target space, and so the metaphor finds its most appropriate source image through different associative iterations of that blending process.

Sometimes an emergent sign may be generated from a blend of two metaphoric images, for example a single swan from the representation of loneliness, and an iced over lake which might be evocative of 'life suspended'. When brought together in a further blend space may generate an emergence, such as the swan reflected in the ice (E), which might evoke the memory of the 'other half', 'the missing mate'. This in turn could suggest an image of the pair and the single in the same space, which is emotionally resonant as a sign (F). The reflection is not present in either image alone, but emerges from the blend of the two original metaphoric images to give something new and resonant, and capable of acting as a sign with emotional valence. This new image may have more co-activation with the target emotional representation at the abstract emotional level than either of the first two alone. In effect, the image becomes an acceptable objective correlative through the number of shared activations that its attached emotional valence has with the target emotion. This is represented diagrammatically in figure 2 below:

In this diagram of the wider process, the emotional valence evoked by the sign may fulfill conditions represented in the emotional goal state (G in Figure 1), so that the image matches the required objective correlative. Again this may be an emergent property of the two representations in the input spaces being combined to give a sufficiently increased activation level in the neuronal arrays, so that attentional processes are activated and the resonant sign 'pops up' as an insight. There may also be a set of artistic goal conditions, which the generated image must fulfill, related to novelty and the poet's knowledge of their field (H). If both conditions are activated, this increased activation could stimulate the reward pathways (both emotional and aesthetic) (I) sufficiently so that the image can spring into consciousness. This may be because the increase of activation or its reinforcement is inherently pleasurable as Martindale suggests, and this in turn may be thought of in terms of providing the autotelic experience described by Csikszentmihalyi as pleasure inherent in the task itself.

Since there will be internalised cultural norms and expectations, which will form part of the associative pattern and the overall activation array, there may also be processes whereby these norms may be flouted, either consciously or unconsciously. This might allow us to generate a sense of novelty through *not* having a great deal of overlap with other activation structures stored in memory, which relate to our knowledge of the wider field, and what has been previously done in poems. These will undoubtedly have some effect on the associative connections made, but they are not likely to act in a prohibitive manner, since the way the activation systems seem to operate in the brain, and the way activation seems to spread through the system, is based on statistical and probabilistic processes.

Figure 2: Example of emotional valence and image blending.



Speculative as such a model is, it is a thought experiment, grounded in the neuropsychological evidence, and what appears to be an appropriate cognitive model, I hope that it offers a way of thinking about how the cognitive and emotional processes might interact in the making of verbal, and by extension, other forms of representational art, while also allowing space in the model for ‘expertise’ effects which are themselves not straight forward. It also allows for mechanisms by which unconscious and cultural biases may feed into and influence the process. The proposed model is extremely fluid, and inherently iterative and recursive, because levels of activation in one part will change activations in the other parts of the model through spreading activation over very short periods of time. It might be thought of as a fluid system constantly in motion, but which, through bottom-up attentional processes described earlier, allow snapshots to emerge, as fully formed images and metaphors, already carrying emotional valence and a semiotic weight, which can then be recorded and worked upon by the conscious, convergent, thought processes of the writer, who can then use the material, change it, feed it back into the unconscious, associative, and divergent system in order to generate more novel images from the sea of constantly fluctuating unconscious thought.

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[1] These various perspectives on creativity can be found in James C. Kaufman and Robert J. Sternberg, eds. *The Cambridge Handbook of Creativity* (Cambridge: Cambridge University Press, 2010). See also the system theory of Mihaly Csikszentmihalyi, *Creativity: Flow and the Psychology of Discovery and Invention* (New York: Harper, 1996).

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