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Special Issue: The Uses of Poetry

Metaphor, Simile, Analogy and the Brain

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Metaphor, Simile, Analogy and the Brain

Fox (1993) argues that the poetic function of language fulfils the human need to symbolize. Metaphor, simile and analogy provide examples of the ways in which symbolic language can be used creatively. The neural representations of these processes therefore provide a means to determine the neurological basis of creative language. Neuro-imaging has demonstrated that while metaphor, simile and analogy activate some areas of the brain in common, they also each activate different areas. This suggests that creative language has had sufficient evolutionary importance to be processed within more than one neural system. Additionally, the neuro-imaging data suggests that symbolic language activates areas beyond the language centres and therefore is encoded using sensorimotor representations. Here we will discuss the neural representations of metaphor, simile and analogy, and will reflect on the neural systems which have evolved to support symbolic language and how this understanding might be used to help develop skill in creative language.

Keywords: metaphor; simile; analogy; figurative language, neuroscience, creativity

While metaphors might be considered the province of authors and poets, our everyday language is rife with both idiomatic and novel metaphors and new metaphors are often created in everyday speech. For instance, recent metaphors for the UK economy abound and include it being described as “a broken down vehicle”, “a force of nature”, or “a patient on a trolley”. The metaphor chosen has consequences since what we do about the economy will depend on whether it is deemed to respectively need fixing, be out of our control, or require some sort of medical intervention. What is clear from the number of new comparisons is that creating new metaphors is not difficult.

The ease with which we can construct new metaphors suggests that these might arise from the ways in which we process language neurologically. If this is the case, then a greater understanding of the processes that give rises to metaphorical language might

help to provide suggestions for ways to encourage the formation of the novel metaphors that are such an integral part of poetic writing. In this paper, I will discuss the different neural systems that are used to process different forms of figurative language. The degree to which cognitive processes are embodied in sensorimotor form will provide a framework for this discussion. This will be used to consider the degree to which our ability to both understand and create figurative language is related to our ability to describe abstract concepts (e.g. time) by comparing these to sensorimotor constructs (e.g. motion, and/or direction in space) that are more easily imagined.

Metaphor involves a comparison between two disparate concepts or ideas in a manner that can vary in novelty. In all cases, one of the concepts or ideas is the primary subject of conversation or thought. The second concept is introduced to create a deeper understanding or to introduce a new way of thinking about the initial idea. Black (1954-55) and Jollimore (2009) have argued that metaphors are used to “organise” our thoughts: one concept provides a filter through which a second concept is viewed such that some features are emphasised over others. For instance, Black (1954-55) uses the example of calling a man a ‘wolf’ which he notes ‘suppresses some details, emphasises others—in short, organizes our view of man’.

While all metaphors compare concepts the nature of the comparison can differ. In some cases the concepts have clear commonalities that might be based, for instance, in their appearance. For instance, describing dandruff as falling snow immediately conjures up an image that evokes the severity of the condition. However, other metaphors involve the comparison of two concepts that are inherently different and so rely on a wider understanding of the possible properties that these might have in common. Thus, to make sense of a comparison between love and a roller-coaster requires that the analysis goes beyond the images that each evoke and considers their

common properties. In this case, the comparison is made on the basis of the fluctuating emotions that each induces and perhaps in the sense of lack of control that is created. Importantly, reinterpretation of one or both concepts is required.

A full description of how metaphors are understood requires description of a neural mechanism that is able to differentiate between phrases that should be taken literally and those that require figurative interpretation, and an understanding of how the comparison between concepts takes place in the brain. Understanding the nature of the possible neural comparisons that are available and the neural substrates that are activated during metaphorical processing might help at least to constrain and at best to explain our ideas of how metaphors emerge within our language.

In this paper, I aim to outline some of the current theories of metaphor and to use neuroscientific literature in this area to determine which theories are more plausible. While this will not be a comprehensive review of all theories of figurative language, I will attempt to outline some of the main theories of metaphor from philosophy, cognitive linguistics and psychology. I will consider what predictions each makes about the neuroscientific representations that would be required to provide a mechanism for metaphorical thinking and then will review the neuroscientific literature to determine whether there is neuroscientific data which excludes some interpretations of metaphor, or at least constrains ways in which we might think metaphorically and also which theory or theories are currently best supported. I will then consider neural models of metaphor creation and consider how these might provide ideas for how to create the sort of novel metaphors that are an intrinsic part of poetry and other forms of creative writing.

Systems in the Brain

The brain can be thought of as a collection of neural circuits (or modules) that process different types of information. For instance, modules in the occipital (or visual) cortex at the rear of the brain process different aspects of visual information like form, colour and movement, modules in the temporal (or auditory) cortex process auditory information like tone and loudness, while modules in the motor cortex process speed and strength of movement. More complex modules take information from sensory and motor systems and combine these to interpret our world and drive behaviour. These areas that combine information are known collectively as the association areas.

The size of the human brain is constrained by the size of skull that can pass through the birth canal without life-threatening damage to mother or child. This constraint has resulted in adaptations that increase the processing power of the brain without increasing the size. One adaptation is that, rather than having the same functions represented by modules on both sides of the brain, the human brain has evolved with hemispheric specialisations such that the left and right hemispheres of the cortex have different functions. Thus, the module that is responsible for expressive language (Broca's area) is found in the left frontal lobe, while the module for receptive language (Wernicke's area) is found in the left parietal lobe. The equivalent parts of the brain on the right hand side are also involved in language but the equivalent of Broca's area controls our ability to speak with prosody (intonation, stress and timing patterns of speech) while the equivalent of Wernicke's area controls our ability to understand prosody. Thus, the brain has evolved to process more aspects of speech by devolving different tasks to different sides of the brain. Notice, however, that it is impossible to understand speech fully without interactions between speech representations on both sides of the brain. The neural systems which both organise how we speak and

interprets our understanding of speech will require interactions between areas of the brain in both hemispheres.

A similar case can be made for systems which control creativity. While it has clearly been shown that areas within the right cortical hemisphere of the brain are active for creative tasks, this does not mean that we are only creative in our right brains. Rather, this suggests that complex creative tasks recruit areas of the right hemisphere in addition to left hemisphere. Creativity will require a complex neural system requiring both left and right cortical areas. Different creative tasks will recruit different modules and it is these differences in the systems recruited during the understanding and construction of figurative language that will be explored further here. By comparing and contrasting the areas of the brain that are activated during different tasks, we can determine the neural system(s) that are used to represent and create metaphor, analogy and simile. This will provide insight which can be used to help students to be more creative when using figurative language.

Aristotle on metaphor

While there have been many different approaches to metaphor, one of the first individuals to define the structure of metaphor was Aristotle (Shelestiuk, 1998). He noted that metaphor depends on the ability to perceive similarities between concepts (Aristotle, 1984: 669) and this structure for metaphor is still used today.

In terms of the neuroscience, one particular assumption made by Aristotle had particular relevance. He argued that metaphor was simile in disguise. In his work on Rhetoric, he states that:

The simile is also a metaphor. The difference is but slight. When the poet says of Achilles that he

“Leapt on the foe as a lion “

this is a simile; when he says of him

“the lion leapt,”

it is a metaphor. [Similes] are to be employed just as metaphors are employed, since they are really the same thing except for the difference mentioned. (Aristotle, *Rhetoric*, 3.4 1406b)

Aristotle argued that when two concepts are compared through metaphor there is a temporary change of usage of one of the concepts to allow it to stand for something new. Several theorists have argued against this interpretation on the basis that associations between concepts change depending on whether they are considered either as similar to one another or identical to one another. To give an example, it would be equally plausible to say:

My father was an anchor to me

Or

My father was like an anchor to me

In the first case, the comparison suggests that things have changed. When the father acted as an anchor there was stability which is now lost. In the second case, there is only the idea that a father contributed stability with less of the sense of loss. Thus, moving from metaphor to simile has resulted in a change in perspective which changes the meaning. The degree to which this is true might depend on the strength of the relationship between the two concepts that are being compared. If the two concepts are very similar, then the difference in interpretation between metaphor and simile is likely

to be less dramatic. For instance, we might say:

She has an encyclopaedic mind

Or

Her mind is like an encyclopaedia

Here the difference between the two forms is less dramatic since in each case the comparison is made directly between two ways in which knowledge is stored.

This potential difference in perspective is thought to be an important aspect of figurative language. If perspective changes with the form of the figurative language, then this might indicate differences in the representation of simile and metaphor in the brain. Each form of figurative language might activate different associative networks. Certainly, the argument that simile and metaphor are “the same thing” would be refuted if each activated a (partially) different network in the brain. Alternatively, if, as Aristotle suggested, similes and metaphors are equivalent linguistic structures, they should activate similar areas of the brain.

Shibata and colleagues (Shibata, Toyomura, Motoyama, Itoh, Kawabata & Abe, 2012) used fMRI to determine whether the same neural structures are activated by metaphor and simile. Behavioural results demonstrated that metaphorical sentences took significantly longer to process (1924 ms) than simile sentences (1782 ms), literal sentences (1309 ms), and anomalous sentences (1636 ms). This suggests that metaphors require more neural processing than similes or literal sentences.

The results of brain imaging demonstrated that both simile and metaphor sentences activated the left inferior frontal gyrus, an area of the brain used in discourse comprehension, detection of semantic anomalies and detection of ambiguous meaning. However, simile sentences resulted in greater activation of fronto-medial areas of the

brain which have previously been shown to be important in processing coherence. This activation might underlie inference processes required to establish the similarity of concepts within a simile. By comparison, metaphor sentences resulted in greater activation in the right inferior frontal gyrus which is important for extraction of features from the topic and vehicle followed by integration of these concepts. This additional processing would explain the increased reaction time when deciding whether the metaphor sentences made sense compared with time taken to resolve simile sentences. The results of this study suggest that Aristotle was wrong, and that we should treat simile and metaphor as different linguistic constructs.

Since simile and metaphor have different linguistic constructs, this might suggest that it would be possible to be more creative by explicitly activating both systems. When using figurative language creatively, instructing students to think about both metaphors and similes for concepts might result in the creation of a greater range of figurative examples.

Why do we have metaphors?

The underlying neuroscience of figurative language is likely to have resulted from adaptations required for language use. Conversations require the listener to interpret the meaning of a speaker's words. However, since words can be imprecise, it is possible for the speaker to intend a meaning that is different to that carried within a literal interpretation of the spoken words. This was defined as conversational implicature by Grice (1989). Thus, even in typical conversations where the meaning is not metaphorical, the listener has to determine the speaker's intent for their utterances over and above any possible literal interpretation. This has been used to good effect in literature, as when Mrs Malaprop is heard to declare:

Sure, if I reprehend any thing in this world it is the use of my oracular tongue, and a nice derangement of epitaphs. (Sheridan, *The Rivals*)

In order to interpret the meaning of this sentence, the listener can replace each incorrect word with a phonologically, closely-related correct version. However, the meaning can be construed without this one-to-one mapping since language is interpreted more than literally. Thus, the overall meaning can be surmised by considering the speaker's intention. Indeed, we must be able to hold multiple interpretations of one sentence in mind since in this case we are amused by the difference between the actual meaning and the intended meaning. Here, the assumption is that meaning, whether in metaphor or in other types of communication, can be assumed through paraphrasing in order to interpret the intent of the words.

Our use of language is idiosyncratic such that each speaker's intent for a similar utterance can be different. For instance, individual words can have different meanings in different parts of the country or between different countries that speak the same language. This will result in a change in the intended meaning from any literal interpretation. The image that is conjured by the phrase: 'they were both wearing suspenders' is very different in America where suspenders are the elastic item of clothing worn over the shoulders to hold up trousers in contrast to the meaning in the UK where this is an elastic strap that is attached to a stocking to hold it up. Culturally, the association that has formed in our brains between the word "suspenders" and the image of someone wearing suspenders is different. This is only one example of how communicative intent can vary from person to person or from brain to brain.

As a result of this idiosyncrasy, the wider principle of metaphor has become part of our shared communicative intent. One way in which communicative intent can be constructed is to create novel meanings by linking objects which are not usually

associated but have shared properties. The meaning is surmised by considering what properties the objects have in common. When hearing an unfamiliar combination of ideas, for instance:

A noble metaphor, when it is placed to an advantage, casts a kind of glory round it, and darts a luster through a whole sentence. (Joseph Addison, *The Spectator*, July 3, 1712).

In this example, the listener has to determine what property or properties the primary idea (a noble metaphor) has in common with the other expressed ideas (glory and lustre). One possibility is that they all share a common property of extending a benefit from an individual aspect to the whole event. The noble metaphor enhances the whole sentence as glory on the battlefield enhances all warriors or adding lustre to a ceramic makes the whole object shine. Thus, in this interpretation of metaphor, their use is based on a psychological property of attempting to understand an imprecise and non-literal means of communication by extending the interpretation to include properties held in common. If we extend the interpretation of words to allow metaphorical meaning we might predict that metaphor would activate extended regions of the brain in comparison to literal interpretations.

Increased activation of the right hemisphere (with concurrent left hemisphere activation) has been implicated in attention to novelty (McGilchrist, 2010), and, more generally, to creativity (e.g. Abraham, et al., 2012; Shamay-Tsoory, Adler, Aharon-Peretz, Perry & Maysel, 2011). If metaphorical thinking requires expanded neural processing, one possibility would be that right hemisphere language centres would also be recruited during this type of processing. Many studies have addressed the role of activation in the right hemisphere for metaphorical processing with some finding evidence (e.g. Schmidt & Seger, 2009; Rutter, *et al.*, 2012; Yang, 2014), and some

failing to find evidence for specific right hemisphere processing (e.g. Lee & Dapretto, 2006; Rapp, Leube, Erb, Grodd and Kircher, 2004).

One possible explanation for these different findings is the type of stimuli that were used in each study. Involvement of areas of the right hemisphere in metaphorical processing might occur only when the complexity of the metaphor is high. Thus, when metaphorical and literal use of words (Lee & Dapretto, 2006) or short phrases (Rapp, et al., 2004) were used, processing was only found in areas of the left hemisphere. In both studies, metaphorical processing resulted in greater activation of the left inferior frontal gyrus (detection of ambiguous meanings) and the left inferior temporal gyrus (non-literal meaning making). Previous studies have shown the importance of the inferior temporal gyrus to metaphorical processing using patients with lesions to this area. When these patients were asked to choose a meaning for metaphorical sentences, they chose the literal meaning.

In their study, Rutter and colleagues asked participants to judge the unusualness and appropriateness of more complex sentences. While the conceptual expansion required for highly unusual, highly appropriate sentences resulted in increased activity in the left and right inferior frontal gyrus. In comparison, sentences that were either only highly unusual or only highly appropriate resulted only in activity in the left inferior frontal gyrus. Thus, the expansion of processing to the right hemisphere appears to result not from novelty alone or the appropriateness of the sentences alone but the conjunction between novelty and appropriateness.

Schmidt and Seger (2009) considered the role of familiarity, difficulty and figurativeness of metaphors in activating expanded regions of the brain including the right hemisphere. In a review of the imaging studies to date, eight out of 14 studies reported right hemisphere activity during metaphor processing. This was related to the

difficulty of the task with expansion to right hemisphere only occurring in more difficult tasks. To test this further, participants were shown literal sentences (e.g. the computers at my house are new), easy-familiar metaphors (e.g. freedom is a breath of fresh air), easy-unfamiliar metaphors (e.g. the dog's stomach is his master's alarm clock) and difficult-unfamiliar metaphors (e.g. A smile is an ambassador). As in previous studies, there was greater activation of the left inferior frontal gyrus during metaphorical processing in comparison to literal sentence processing. In addition, activation of the areas of the right hemisphere were found for sentences with low familiarity or high figurativeness. This demonstrates that right hemisphere involvement in metaphorical processing is activated as a response to decrease in familiarity and increase in task difficulty.

These studies confirm that more regions of the brain, and in particular areas in the right hemisphere are required to interpret metaphors that are unfamiliar and/or difficult in comparison to literal sentences therefore supporting the theory that imprecise or figurative language recruits additional processing power. It is therefore likely that creating novel metaphors and similes will also require additional processing power.

Conventional versus novel metaphors

Many metaphors have obtained conventional meanings within a culture, for instance, "to walk a mile in someone's shoes" or "as still as a mill pond" and therefore have well recognised alternate meanings. In these cases, the new meaning will have become associated with the metaphor without a need for any intermediate comparison of aspects of the two concepts and therefore will be more easily accessible in the brain. This suggests that conventional metaphors should be processed more quickly than novel metaphors.

In poetry however metaphors are novel constructions:

Somewhere between the sayable and the unsayable, poetry runs. Antidote to the river of forgetting. (From: *Poetic Subjects* by Rebecca Lindenberg)

In the case of novel metaphors, the interpretation of the metaphor has to be created in real time through extension of the possible meanings of the concept to which the novel concept is being compared. Thus novel metaphors are likely to require both more time to process and activation of more areas of the brain than conventional metaphors.

In addition to metaphorical sentences requiring greater neural processing than literal sentences, it is also possible that metaphors that have become over-used in a particular culture require less processing than those that are novel. In the case of over-used metaphors, it is hypothesised that the semantic meaning of the metaphor can be activated directly by the linguistic construct without the need for extended processing. The research reported above in which decreased familiarity of metaphor was related to expansion in the areas of the brain that are activated suggests that familiarity is important. However, this does not provide evidence of direct activation of meaning without further processing since these studies did not compare conventional with easy non-conventional metaphors. What is of interest here is whether words can acquire dual meanings as metaphors become familiar. Thus, for example, it is not necessary to know anything about naval traditions to know the meaning of the phrase “letting the cat out of the bag” since this is understood to mean reveal information that was previously hidden. Indeed, the metaphorical meaning has come to replace the literal meaning over time, though, at some point in time, both meanings might have been accessible.

In order to determine the changes in neural processing that accompany increased familiarity with a metaphor, Cardillo, Watson, Schmidt, Kranjec and Chatterjee (2012)

familiarised participants with sets of novel metaphors over time. At the end of the familiarisation phase, participants were tested on novel metaphors (those they had never seen), moderately familiar metaphors (those they had seen twice) and highly familiar metaphors (those they had seen five times). Neural activity decreased with increasing familiarity in the left and right inferior frontal gyri (language processing), left posterior middle temporal cortex (memory) and right postero-lateral occipital cortex (visual imaging). These findings suggest that familiarity results in less neural expansion. Again, the suggestion here is that creation of new metaphors or similes will require activation of a larger number of brain areas.

Linguistic versus sensorimotor extension

There are several theories of metaphor that suggest that interpreting the meaning of the metaphor depends on the wider semantic relations evoked by selected words. One such interpretation, the semantic twist theory, explains how metaphors are understood by changing the meaning of words within the metaphor so that their meaning is extended from the literal interpretation of the word (Hills, 2012). Skulsky (1986, 1992) suggested that extensions of word meanings can be considered as an on-line improvised dialect or ‘metaphorese’. This requires that both speaker and listener have access to ways to create new metaphors (metaphoric schemes) and means to understand these novel, fleeting meanings (tropes). This will require new associative connections between words and their potential meanings in the language centres of the brain – at least for metaphors that are well known.

More recently, an alternative theory of metaphor has come from the field of cognitive linguistics (e.g. Lakoff, 2014). While linguistic explanations of metaphor assume that analysis of metaphor is a property of the language centres in the brain, the cognitive linguists argue that metaphors involve the manipulation of mental imagery in

order to allow a concrete mental representation to stand for more abstract representations. From this theoretical position, mental functioning is bodily functioning and, in its strongest form, the representations that we describe, whether literally or metaphorically, are all related to objects and actions in the sensory-motor world. In this interpretation, language has developed to communicate information about our sensory world and our actions within this world. In this theory, the physical properties of the world constrain the types of representations that are activated linguistically. These constraints are, in turn, imposed when we attempt to discuss more abstract concepts. To provide an example of this, objects can extend horizontally (left to right), in front and behind us, or vertically (up and down). These alternate spatial constraints can be used to represent and constrain our representation of, for instance, the abstract concept of time which can then be visualised as passing from left to right, from bottom to top or from behind to in front of our bodies. Similarly, time can be conceived as passing (e.g. “time flies”) in which case we stand still and it is time that moves, or we can be conceived as passing through time (e.g. “I enjoyed passing time with friends”). Thus, the constraints of objects (their dimensional properties and their movement relative to us) provide constraints for other abstract concepts.

If metaphorical understanding is based on comparisons with objects and actions in the real world, it will require access to the mental representations of the concrete concepts that are to be compared. This predicts that the use of metaphors would result in activation in parts of the brain that best represent the concept (embodied cognition), whether this is visual, auditory, kinaesthetic or motoric rather than purely linguistic activation.

In an influential review paper, Meteyard, Rodriguez Cuadrado, Bahrami and Vigliocco (2012) considered the neuroscientific evidence for embodied cognition to determine

whether cognitive processes are always rooted in perception and action and therefore require sensorimotor representations in the brain rather than purely semantic (or linguistic) representations. They concluded that there was some evidence that abstract concepts activated sensorimotor representations but that these were not always required.

In a recent study which measured the activation of sensorimotor areas of the brain during a metaphor task, Romero Lauro, Mattavelli, Papagno and Tettamanti (2013) used metaphors that incorporated a motion verb that had the same linguistic meaning but different sensorimotor meanings (e.g. The detective throws in the towel versus George threw the logs on the fire). Increased activation was found in the motor regions in the brain for both literal sentences and figurative metaphors suggesting that metaphors can activate sensorimotor representations. However, motor activity was not found for idiomatic metaphors suggesting that not all metaphors require an embodied representation. What is clear, however, is that sensorimotor representations contribute in important ways to our understanding of metaphors. Thus, when students are looking to create novel metaphors, this might be enhanced by asking them to enact the abstract concept thus activating sensorimotor representations.

Creating metaphors

Metaphorical thinking is important not just when reading poetry, but also when writing. Research investigating the neural activation which differentiates creating new ideas from recalling ideas has demonstrated that this requires extended systems in the brain including the left inferior parietal cortex which is known to be important for imagining possible futures (Benedek, *et al.*, 2014). More specifically, metaphor creation has been associated with increased activity in the left angular gyrus, left dorsomedial prefrontal cortex (inhibition of common responses, goal perseverance and selection of best response) and the right middle temporal cortex (activation of unusual responses from

memory). There is also decreased activity in the right temporo-parietal junction, an area of the brain that is active when focussing externally confirming the importance of internal focus when attempting to generate new ideas (Benedek *et al*, 2014).

Novel metaphors are created when people put together ideas that are only loosely associated in their heads. This can feel like hard work since our brains are designed to bring together the ideas that are most strongly associated (e.g. table and chair, or sweet and sour). So, in order to have insight, we have to inhibit these strong associations so that the weaker associations can come to our attention (table and football, or sweet and potato). These more novel pairings are more likely to happen when focus of attention drifts beyond the problem at hand. In a recent study, Beaty, Benedek, Barry and Silvia (2015) measured brain activity while participants generated as many uses as possible for a brick. Increased creativity in this task required co-activation of two neural systems – the socio-emotional network which is activated when we are not focussed on a task, and the executive control network which is activated when we are highly task focussed. The authors suggest that creative thinking requires both internal focus to search for ideas (socio-emotional network) and focussed thinking to concentrate on novel ideas and ignore familiar ideas (executive control network). These two networks are most likely to operate together when people are given time and space to think in a relaxed environment without the demands of deadlines or urgent tasks to complete. This will also allow students to focus inwardly. Thus, when asking students to write creatively, more innovative and novel figurative language is likely to be produced in calm and relaxed environments free from other task demands.

In another study, however, Wei *et al.* (2014) demonstrated that exposing individuals to the ideas of others both increased creativity behaviourally and increased the

connectivity between the medial prefrontal cortex and the middle temporal gyrus. This might suggest a two stage process for creation of new metaphors – first allow students to discuss possibilities, and then create a relaxed and inwardly focussed environment for students to contemplate new ideas.

Conclusions

In this paper, I have attempted to bring evidence from neuroscientific studies to bear on our understanding of how we process metaphors, similes and analogy. This evidence suggests that we have multiple brain systems to process figurative language of different types. Thus, different systems in the brain are recruited when analysing the meanings of metaphors, similes and analogies. Clearly, figurative language has an important adaptive role. One possibility is that initial understanding of the world through sensorimotor representations (some form of embodied cognition) has been expanded to provide a basis for more abstract thought. This idea is supported by the evidence which shows that interpreting metaphors can result in activation of sensorimotor areas of the brain in addition to semantic or linguistic areas. This allows us to bring representational frameworks required for action on a sensory world to bear on abstract concepts that have no sensorimotor representations. As such, much of our thinking is metaphorical – time passes, love hurts and cultural worlds collide.

These findings have implications for teaching both how to read and how to write poetry. When reading poetry, it might be useful to communicate to students the ubiquity of figurative constructs in our everyday language and the necessary function these play in communicating abstract concepts. Not only is speaking literally almost impossible, but the nature of the metaphors used to describe abstract constructs can drive different behaviours (Thibodeau & Boroditsky, 2011). When people were asked to provide solutions to crime, their solutions changed depending on whether they read

about crime as a wild beast or crime as a virus. Since metaphors are ubiquitous in our language, our brains are well equipped to process these. While the metaphors used in poetry are often more novel, they are similar in structure to those in frequent daily use. Thus, students can be reminded that they use metaphors constantly and therefore are already good at both understanding and creating these.

Greater conceptual expansion is often required to provide meaning to poetical metaphors, and this results in activation in wider networks within the brain. As with all neural functions, the more these pathways are used, the more connected they become. Thus, the more experience we have with unusual metaphors, the better able we are to understand new metaphors when we meet them. Providing students with relaxed environments where they can be encouraged to day dream and focus on their internal world can help provide these experiences and thus build the necessary networks.

Experience with reading poetry and interpreting metaphors will also contribute to the ability to conceive of novel metaphors. The increase in creativity and brain connectivity that resulted from exposure to others' ideas suggests that it might be possible to increase the novelty of metaphors when writing poetry by bringing together groups of people who write poems. While this has not yet been directly tested, the experience of individuals who benefit from attending writing groups provides anecdotal confirmation of this theory.

References

Abraham, A., Pieritz, K., Thybusch, K., Rutter, B., Kroger, S., Schweckendiek, J., Stark, R., Windmann, S. & Hermann, C. (2012). Creativity and the brain: Uncovering the neural signature of conceptual expansion. *Neuropsychologia*, 50, 1906-1917.

- Addison, J. (1712) On the pleasure of the imagination. *The Spectator*, No. 421, Thursday July 3, 1712.
- Aristotle (1984) *Poetics*. In: *Collected Works in 4 Volumes*, vol. 4, M.I. Gasporov (trans.). Moscow: Progress.
- Aristotle, Rhetoric in Rhetoric: A Theory of Civic Discourse, George A. Kennedy (trans.), Oxford: Oxford University Press, 1987.
- Bambini, V., Gentili, C., Ricciardi, E., Bertinetto, P.M., & Peitri, P. (2011) Decomposing metaphor processing at the cognitive and neural level through functional magnetic resonance imaging. *Brain Research Bulletin*, 86, 203-216.
- Beaty, R., Benedek, M., Kaufman, S. Y Silvia, P. (2015) Default and executive network coupling supports creative idea production. *Nature: Scientific Reports*, 5, 10964.
- Benedek, M., Jauk, E., Fink, A., Koschutnig, K., Reishofer, G., Ebner, F. & Neubauer, A.C. (2014) To create or to recall? Neural mechanisms underlying generation of new ideas. *NeuroImage*, 88, 125-133.
- Black, M. (1954 – 1955) Metaphor. *Proceedings of the Aristotelian Society*, 55, 273-294.
- Cardillo, E.R., Watson, C.E., Schmidt, G.L., Kranjec, A. & Chatterjee, A. (2012) From novel to familiar: Tuning the brain for metaphors. *NeuroImage*, 59, 3212-3221.
- Dietrich, A. & Kanso, R. (2010) A review of EEG, ERP, and neuroimaging studies of creativity and insight. *Psychological Bulletin*, 136, 822-848.
- Fox, C. (1993) *At the Very Edge of the Forest: The Influence of Literature on Storytelling by Children*, London: Cassell
- Gibbs, R., & Nayak, N. (1989). Psycholinguistic studies on the syntactic behavior of idioms. *Cognitive Psychology*, 21, 100-138.
- Gibbs, R., Nayak, N., & Cutting, C. (1989). How to kick the bucket and not decompose: Analyzability and idiom processing. *Journal of Memory and Language*. 28, 576-593.
- Gibbs, R., & O'Brien, J. (1990). Idioms and mental imagery: The metaphorical motivation for idiomatic meaning. *Cognition*, 36, 35-68.
- Gibbs, R., Costa Lima, P.L. & Francozo, E. (2004) Metaphor is grounded in embodied experience. *Journal of Pragmatics*, 36, 1189-1210.
- Grice, H.P. (1989) Logic and Conversation, Lecture 2. In: *Studies in the Way of Words*, Cambridge, Massachusetts and London: Harvard University Press, 22–40.

- Hills, D. (2012) Metaphor, *The Stanford Encyclopaedia of Philosophy* (Winter 2012 Edition), Edward N. Zalta (ed.), URL: <http://plato.stanford.edu/archives/win2012/entries/metaphor/>.
- Jollimore, T. (2009) “Like a picture or a Bump on the head”: Vision, cognition, and the language of poetry. *Midwest Studies in Philosophy*, 33, 131-158.
- Jung-Beeman, M., Bowden, E., Haberman, J., Frymiare, J., Arambel-Liu, S., Greenblatt, R., Reber, P., & Kounios, J. (2004) Neural activity when people solve verbal problems with insight. *PLOS One*, 4, 500-510.
- Lakoff, G. (2014) Mapping the brain’s metaphor circuitry: metaphorical thought in everyday reason. *Frontiers in Human Neuroscience*, 8, Article 958.
- Lee, S. S. & Dapretto, M. (2006). Metaphorical vs. literal word meanings: fMRI evidence against a selective role of the right hemisphere. *NeuroImage*, 29, 536–544;
- Lindenberg, R. (2014) *The Logan Notebooks*, Center for Literary Publishing.
- McGilchrist, I. (2010) Reciprocal organization of the cerebral hemispheres. *Dialogues in Clinical Neuroscience*, 12, 503-515.
- Meteyard, L., Rodriguez Cuadrado, S., Bahrami, B. & Vigliocco, G. (2012) Coming of age: A review of embodiment and the neuroscience of semantics. *Cortex*, 48, 788-804.
- Rapp, A.M., Leube, D.T., Erb, M., Grodd, W. & Kircher, T.T.J. (2004) Neural correlates of metaphor processing. *Cognitive Brain Research*, 20, 395-402.
- Romero Lauro, L.J., Mattavelli, G., Papagno, C. & Tettamanti, M. (2013) She runs, the road runs, my mind runs, bad blood runs between us: Literal and figurative motion verbs: An fMRI study. *NeuroImage*, 83, 361-371.
- Rutter, B., Kroger, S., Stark, R., Schweckendiek, J., Windmann, S., Hermann, C., & Abraham, A. (2012) Can clouds dance? Neural correlates of passive conceptual expansion using a metaphor processing task: Implication for creative cognition. *Brain and Cognition*, 78, 114-122.
- Schmidt, G.L. & Seger, C.A. (2009) Neural correlates of metaphor processing: The roles of figurativeness, familiarity and difficulty. *Brain and Cognition*, 71, 375-386.
- Searle, J. R. (1979a) Metaphor. In: *Expression and Meaning: Studies in the Theory of Speech Acts*, Cambridge and New York: Cambridge University Press, 76–116.

- Searle, J. R. (1979b) Literal Meaning. In: *Expression and Meaning: Studies in the Theory of Speech Acts*, Cambridge and New York: Cambridge University Press, 117–36.
- Shamay-Toory, S.G., Adler, N., Aharon_Peretz, J., Perry, D. & Maysseless, N. (2011) The origins of originality: The neural bases of creative thinking and originality. *Neuropsychologica*, 49, 178-185.
- Shelestiuk, H. (1998) Approaches to metaphor: Structure, classifications, cognate phenomena. *Semiotica*, 161, 333-343.
- Sheridan, R.B. (1905) *The Rivals*. William Heinemann.
- Shibata, M., Toyomura, A., Motoyama, H., Itoh, H., Kawabata, Y. & Abe, J-i. (2012) Does simile comprehension differ from metaphor comprehension? A functional MRI study. *Brain & Language*, 121, 254-260.
- Skulsky, H. (1986) Metaphorese. *Noûs*, 20, 351–69.
- Skulsky, H. (1992) *Language Recreated: Seventeenth-Century Metaphorists and the Act of Metaphor*. Athens: University of Georgia Press.
- Thibodeau, P. H. & Boroditsky, L. (2011) Metaphors we think with: The role of metaphor in reasoning. *PLoS One*, 6, e16782.
- Varatianian, O. (2012) Dissociable neural systems for analogy and metaphor: Implications for the neuroscience of creativity. *British Journal of Psychology*, 103, 302-316.
- Wei, D., Yang, J., Li, W., Want, K., Zhang, Q. & Qiu, J. (2014) Increased resting functional connectivity of the medial prefrontal cortex in creativity by means of cognitive stimulation. *Cortex*, 51, 92-102.
- Yang, J. (2014) The role of the right hemisphere in metaphor comprehension: A meta-analysis of functional magnetic resonance imaging studies. *Human Brain Mapping*, 35, 107-122.