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An Empirical Study on the Mechanisms of Creativity in Visual Arts

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Abstract

This collaborative research between a visual artist and a cognitive scientist is based on the assumption that the so-called *aha* moment actually emerges from a number of interacting micro-processes. The empirical study presented here focuses on the creative process involved in connecting two pictures by painting another picture in the middle. This technique was involved in four *Infinite Landscape* workshops conducted at Art Museums in Japan and Europe over the last five years. Based on the artist's verbal recollection of the ideas that occurred to him as he drew each of the connecting pictures, we identify the micro-processes and cognitive mechanisms underlying these ideas, and discuss their implications for modeling creativity.

Keywords: Creativity; emergence; perceptual features; similarity; surface features; visual art.

Introduction

A central problem in creativity research is how new ideas are generated. In recent years, it is gradually being realized that creativity is an emergent property of many interacting micro-processes (Dunbar 1997; Sawyer 2006). These micro-processes can occur within a cognitive agent itself, or in different agents within a group or society. Our larger goal in this research is to study and model these micro-processes.

In particular, we are focusing on the creative processes in visual art. For this, one could consider the creative insights spanning over the entire career of an artist (for example, Dali 1993); or over a part of the career of an artist (for example, Okada *et al.* 2009); or across several artists (for example, Mace & Ward 2002). When a longer period is covered, it is difficult to get information about the micro-processes involved in the creation. Even when one focuses on the creation of a particular work, if the goal is too open-ended, the micro-processes are too unrestrained and divergent. For example, in the study of Mace & Ward (2002), twenty-five artists were interviewed to get data about their creative processes. But because the artists could create any work they wanted, the insights from their self-reflection are only useful for a macro-level model.

When a work is created under constraints, it often increases the level of creativity required (Stokes 2005); it also makes it easier to compare data across different works because they were created under the same constraint. With this in mind, we focused on the task of creating a picture to connect two given pictures seamlessly, as described below.

Background: *Infinite Landscape* Workshops

This research is a collaborative effort between a visual artist [henceforth referred to as *the Artist*] and a cognitive scientist. Over the last five years, the Artist conducted four workshops at art museums in Japan and in Europe with the common theme *Connecting different spaces*. In each workshop, there were 15-19 participants, all children (8-14 years) except in one workshop there were six adults. Three workshops conducted in Japan followed the following modus operandi.

In the first step, the children were shown about 20 photographs of scenery from around the world, and then they were asked to draw imaginary landscapes using the building, people, animals etc. in these pictures as they liked. In the second step, the Artist brought the children's imaginary landscapes to his studio, and then he drew one picture to be inserted between every two pictures of children, so that all three pictures form a seamless scene. One such trio of pictures is shown in Fig. 1: scenes 9 and 10 were drawn by participants, and the Artist drew S9 to connect the two.
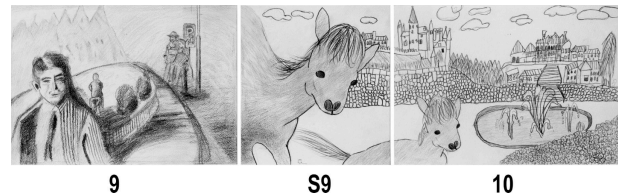

9　　　　　　　S9　　　　　　　10

Figure 1

In the third and final step, all the pictures were connected in a ring without a beginning and an end, and the completed ring was suspended from the ceiling of the museum where the workshop was held. The ring was placed with the paintings on the inner side, so that the viewer is surrounded by the work while viewing it.

The fourth workshop conducted in Kraków was similar except for two differences. One is that the children were not shown any photographs in the first step, but half the group was asked to draw Kraków as they imagined it in the past; and the other half the future of Kraków, all based on their imagination. This was only suggested to them and the participants drew whatever they wished. The other difference was that in the final step, the completed ring was placed on a glass floor.

Methodology

Our overall methodology for this research project is as follows. In the first step, the Artist recorded various ideas that occurred to him as he drew each of the connecting pictures. It should be emphasized that in this step, the Artist was not aware of any potential hypotheses as to what we might be looking for in this data. In the second step, we analyzed these self-reflections to identify various micro-processes and their interactions with each other that were instrumental in the creation of the macro-level connecting pictures. In the third step, we posit cognitive mechanisms underlying these micro-processes. Finally, we plan to model these mechanisms in a computational system.

The research presented in this paper focuses on Steps 2 and 3. From the self-reflection data collected about each of the four workshops, we identified instances where a new idea was generated that became a major theme in the finished picture. This identification itself is also based on the self-reflection data. In other words, we are relying on the Artist's own judgment of the novelty factor. We should emphasize here that because of the nature of the task, namely to connect the two pictures seamlessly, there were many cases where the Artist copied elements, extended texture, color or shape from one of the pictures to the middle picture, and so on. Though we have included such micro-processes in our complete analysis, they are not discussed here.

Mechanisms of Creativity

We present here several examples of the Artist's thought processes as he sought to connect the given two pictures seamlessly. The Artist's original comments were in Japanese, and are translated here with minor editing by the other author of this paper. We have also labeled and categorized these examples based on the factor that played a key role in the overall theme and the composition of the connecting picture.

Surface Similarity

In several instances, similarity with respect to color, shape or texture played a key role in the genesis of the connecting picture, and in such a way that a semantic construct was created. This is illustrated by the following examples.

Similarity in shading or texture: Consider the Artist's observations concerning Fig. 1: "These two had completely different atmosphere from each other. Sketch 9, drawn by an adult participant, is a scene set at dusk; a person looking at the artist is drawn wearing a sad expression. Sketch 10 has a bright atmosphere with flowers, fountains, buildings on a hill, and a horse. Moreover, each picture had an important character in the bottom left. The idea for connecting these sketches came to me while looking at the wonderful horse in 10. I thought of putting a parent horse running nearby. Because the background color of 9 and the body color of the horse in 10 was the same, I transformed the background of 9

into the parent horse in S9, which became a nested image structure. Then I extended the baby horse and the hill with the buildings."

Here the same shading for the horse's body in 10 and the background in 9 led to the idea that the background in 9 can be morphed into the mother horse in S9, which results in an Escher-like nesting of pictures. The same phenomenon is also seen in Fig. 2: "There was the ground and the sky in the left one-third of 11, but the sea covered the remaining part on the right. In 12, a vast meadow was drawn with rich pictorial details. Here my attention was drawn to the connection between the color of the giant bridge in 11 and the color of the sky in 12. In S11 I drew the enlarged bridge of 11 and connected it with the picture on 12, which resulted in a nested image structure."

These two examples show how texture or shading triggered an association that led to nested image structures.
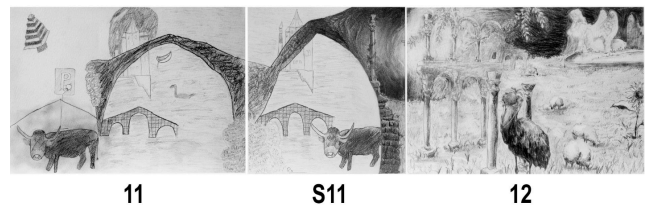

11   **S11**   **12**

Figure 2

Similarity in shape: In Fig. 3, it is the shape of the curves that started a chain of thought: "I felt these two could not be connected with the techniques I had used so far. Then I noticed the wall on the top-right corner of 12 and the curved ledge surrounding the fountain in 13. Using these two curves, I drew a large Mobius strip in S12. As this Mobius strip divided S12 into four sections, in each section I extended the adjacent scenery. It felt like pouring in the scenery. Accordingly, I was able to connect them without blending, and this became the first work with this technique."

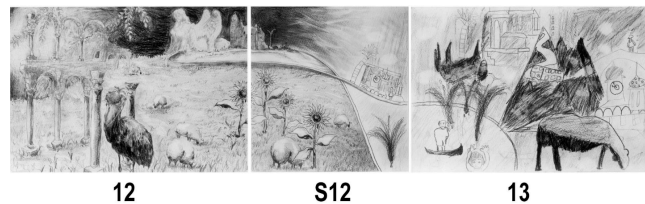**12**   **S12**   **13**

Figure 3

Surface features trigger a new concept: In Fig. 4, surface features of an object drawn by the participant reminded the Artist of a completely different object, and that became the theme of the connecting picture: "Suddenly my attention was caught by the strange-shaped, cage-like object drawn at the corner fence in the right pencil-sketch. I thought this shape was a piano. Once I could overlap these images, the

line of fence naturally transformed into a musical staff, and I could draw the dragon playing the piano. I made the particles of light in the sky of the left picture as if they are the sound emanating from the piano."
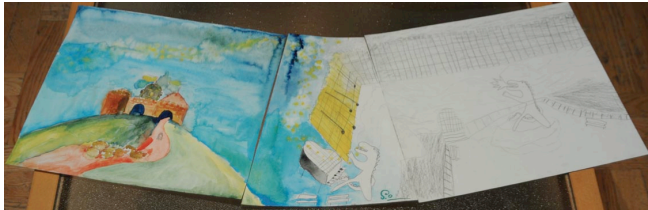

Figure 4

Contrast

There were also several examples where the contrast or the opposition between the two pictures was instrumental in generating a new idea.

Contrast in perspective: In Fig. 5, the contrast between the viewpoints of the pictures was a major factor: "I thought it is not possible to connect 3 and 1. Picture 1 is clearly a bird's eye-view, as if a bird is looking down towards the ground; in contrast, picture 3 has a distinct horizon with a clear separation between the earth and the sky. First I extended the broken train track and the tire tunnel. Then as I was drawing the dark blue river, I thought, 'But where should I extend this river? Towards the top? Towards the bottom? If I extend it below, then I can connect it with the ground of 3. But…' I felt lost. Finally, I resolved to bring the river up. It was a desperate effort. However, at that time I thought of a good way to solve this problem. In the remaining left edge of the picture, I extended the scenery from 3. Finally, to integrate the inconsistent parts of the picture, I floated a number of clouds from 3 on the river. Thus, by using clouds as intermediaries, I was able to connect a bird's eye-view picture with a perspective picture."

Figure 5

Contrast in richness of details: In Fig. 6, it was the contrast between the richness of details that lead to a very interesting result: "Because 8 was a richly detailed realistic presentation, to contrast it with the presentation in 7, I decided to stress dimensionality in the connection. The realistic rocks and the bridge in 8 were rendered in 3-d and were connected with the bridge in 7 that was extended in 2-d. To make this connection smoother and give an accent to the picture, I drew 3 Russian onion domes from 7 into S7."
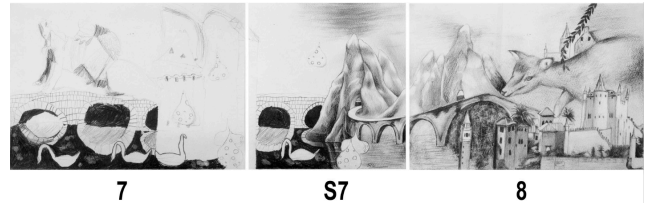

Figure 6

Fig. 7 provides another example: "I thought about how to connect picture 5 with picture 6 that had strong green with dark lines and was rich in details. I thought I could turn the contrast of a picture rich in details and a picture low in details into a pictorial effect. On the top right of 5, there is a game-character like man standing with a trident basking in the sunlight. First, to counter that, I drew a partner woman's figure on top left of S5. But I laid down the trident by her side. I drew most of S5 as an extension of the dynamics of picture 6. On the bottom right of 5, there is an abstract painting-like area, and I placed this dark touch on the left edge of S5. This was a pleasure to work on. When I saw all of the paintings arranged in a ring at the Art Museum in Okazaki, it was obvious that it was picture 5 that was being the heretic and bringing out the effect of difference in richness of details in paintings. This realization was the most important lesson to me from this case."

Figure 7

Semantic similarity/association

There were several examples where similarity at the meaning level played a key role in generating ideas for the middle picture.

Concept retrieval based on semantic association: In Fig. 8, the wisp of smoke coming out of the chimney of a house, suggested the idea of a steam engine: "Perhaps my worst betrayal (in a good sense) of the participants is when I changed the brown house of the robot into a steam engine somewhat arbitrarily. The thread of smoke coming out of the chimney made me do this."

Figure 8

Similar objects: Two objects, both trains, but with surface-level dissimilarities played a major role in Fig. 9: "I first noticed the train in 1 and 2. I admired that even though they both had drawn the same train, their drawing styles were very different, and I felt a strong urge to connect the two trains. First I connected the two train tracks that were cutting across 1 and 2, and then drew the gradual transformation of one train into the other. On the bottom left I drew a swan from 1, and on the top right I drew the water fountains and trees from 2, and then connected the backgrounds of the two pictures."
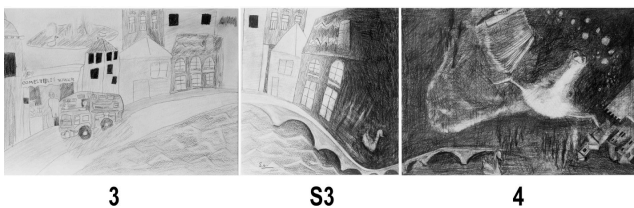

Figure 9

Deliberately Ignoring Meaning

Figure 10

Fig. 10 provides an interesting example where the Artist deliberately chose to ignore the meaning and focused on the surface features only: "At first Sketch 4 was filled-in completely black, and then brightened by eraser. It had no earth and sky, but an ambiguous space from a dark fantasy. Normally, a picture like this cannot be connected with any picture. I decided to connect this dark picture with 3, which had a child-like pictorial space. However, it would be impossible to connect the two in an ordinary way. Here, I decided to ignore all the meanings in these pictures, but instead focus on the pattern of light and dark. I said to myself, 'it is just a blotch'. The only connecting point in

both pictures was the street in 3 and the bridge on the bottom left of 4. I could connect this street and the bridge. Luckily, bottom left of 4 looks like the sea, and bottom right of 3 also looks like a body of water. In S3, I extended the road in 3 in S-shaped curve and connected it with the bridge in 4. Continuing, I also extended the sea. Until here it was traditional technique. The problem was what to do on top of this. On the left part of S3, the only possibility was to extend the street-side houses on 3, so I did that in the same touch. Then I gradually changed the color of houses from gray to black, while introducing spatial distortion, and changing them from solid to liquid. I floated a swan in the dark pond that the buildings were turned into."

This example also illustrates the role of surface features (similarity between the shapes of the road and the bridge) and semantic association based on functionality (roads and bridge are both used for travelling.)

Metaphor

In Fig. 11, an overarching metaphor was generated in trying

Figure 11

to connect a picture with two neighboring pictures. We include a long quote here to familiarize the reader with the context and the thought processes of the Artist: "The child who drew this seemed (and it is my personal impression) emotionally repressed, and who is not accepted as himself by the surroundings. I had decided to not consider the psychological problems of the children, but focus only on the expression of form and color. However, when I was confronted with this work that expressed intense psychological problem, I instinctively thought, 'What can we do to help this heart?' But I am well aware that the most I can do is to finish the work and by having the participants view it as an aesthetic experience send them some kind of message. I placed on both sides of 11 two of the brightest pictures, 10 and 12, and started to connect it with them. The sky in 10 is clear, but the top portion is dull and grey. Even more than that, the colors of gloomy 11 seem to entirely reject any possible connection. In S10, losing to this strong feeling of rejection, I connected the pictures rather abruptly and formally. As a result, I gave angel wings from the globe in the middle of 11 to the swan in the red area of S10. Continuing with connecting 11 with 12, on the spur of the moment, I thought of mixing the color of the water surface. In other words, in the middle of the blood red lake of 11, I poured in a stream of bright blue from 12. I was hoping that the same effect would also occur in the heart of the child who drew 11. I felt relieved instinctively when this work was finished. Furthermore, as a cheering party for the child

who drew 11, I added on the top right of S11 the street lamps and the acorn decorations of 12."

Influence of Other Ongoing Projects

Fig. 12 illustrates a case when an idea was borrowed from another ongoing project of the Artist: "In S6, I first drew the remaining portion of the cow in 6, and then the remaining portion of the cliffs of Cappadocia. Moreover, to connect the complex-shaped terrain in 7 with the savannah meadow of 6, I extended the grey building on the right edge of 6 and transformed the terrain. Incidentally, at the same time I was working on my 'Moire' series, so I made the shape of the grey buildings like the silhouette of Mt. Saint Michel. This became an example of my incorporating a concept of my own in the scene through my pro-active involvement."

Figure 12

Discussion and Related Research

Having gleaned these bits of insights, we now identify four major themes underlying creativity that are highlighted by this study. We comment below on each theme and also discuss previous research related to it.

Role of Surface Features

It has been widely recognized that similarities play a key role in the generation of new ideas (Kokinov *et al.* 2009; Ward 2011.) Although surface similarities are often found to influence memory access and recall (Barnden & Holyoak 1994), most of the research has focused on semantic aspects of the similarity, like structural alignment, for these are considered to be more helpful in problem solving and learning. In fact, surface similarities are often thought to be distracting (Faries & Sclossberg 1994). Our data, however, indicates that surface features can have a significant influence on creation of new ideas in at least two different ways.

Surface similarities between two objects: Here noticing surface similarities between two different objects triggers an exploration for a possible deeper meaningful relation between them, as we saw in many examples above. This is consistent with the results of our earlier studies (Indurkhya *et al.* 2008; Ojha & Indurkhya 2009), where we found that similarities with respect to color, shape, texture etc. facilitate generation of conceptual associations.

Surface features of an object recall a different concept: We saw above how the perceptual features of a cage-like object in Fig. 4 triggered the concept of piano, which became the motif of the connecting picture. This is consistent with a model of perceptual metaphors we had proposed in our earlier work (Indurkhya 2006), where we argued that certain metaphors rely on a perceptual resonance between the images corresponding to the source and the target.

Role of Contrast or Opposition

We found several instances where new ideas or perspective emerged in trying to connect contrasting elements. Many previous studies of creativity have also found that opposition can be a key to generating new insights. For instance, Schön (1963) emphasized that in order to get a new insight about a concept, it needs to be *displaced,* that is, put in the context of other unrelated concepts. Koestler (1964) emphasized that the pattern underlying a creative act is the perception of a situation or an idea in two self-consistent but habitually incompatible frames of reference. More recently, Shapira and Liberman (2009) suggest *psychological distance* as a mechanism for enhancing creativity. They and their colleagues (Jia, Hirt and Carpen 2009) have demonstrated that psychological distance can be induced by such simple devices as taking another person's perspective or thinking of the problem as if it is unreal.

Deliberate Deconstruction of Meaning

We presented one example above where the Artist deliberately chose to ignore the meaning, and focused on the perceptual features like shade and texture. This mechanism is also often acknowledged as a useful heuristic for creativity. For example, Gordon's (1961) *making-the-familiar-strange* is essentially the process of deconstructing the familiar meaning associated with the problem. Similarly, the first step in one of the creativity mechanisms proposed by Rodari (1996) is *estrangement,* where you are asked to see the object as if for the first time, without associating familiar meanings with it.

Interaction of Top-down and Bottom-up Influences

The metaphor and the moiré series examples (Fig. 11 and 12) illustrate the top-down influences in the creative processes. What we mean here is that the psychological state of the artist and her or his past experiences can also influence the particulars of a creative insight. There have been several accounts of creativity that emphasize the interaction of top-down and bottom-up processes (Fauconnier and Turner 2002; Hofstader 1995; Indurkhya 1997).

Conclusions and Future Research

We analyzed data from the Artist's verbal recollection of his thoughts as he drew the middle pictures to connect pairs of pictures seamlessly. From this analysis, we identified a

number of micro-processes that led to the *big picture* idea. In particular, we found that *surface features, contrast*, and *meaning deconstruction* play major roles in the generation of new ideas.

There are two lines of research that we are pursuing from here onwards. One is to develop a meme-based approach to formalize these micro-processes, and implement a computational model of them (Ogawa, Indurkhya and Byrski 2012). Besides, we are also interested in studying the cognitive processes of the viewers as they look at the trio of pictures. The term creativity is generally restricted to the artist or the person who generates the work, design or the artifact; and one does not attribute it to the reader or the viewer. However, we have argued before that in some situations at least, some creativity is required from the reader or the viewer as well (Indurkhya 2007). Moreover, our past research has shown that surface-level perceptual similarities influence how viewers connect pairs of images and relate them conceptually (Ojha and Indurkhya 2009; 2012). It would be interesting to see how this process is affected when there is an intervening picture in the middle; and we would like to study the effect of contrast as well. We plan to conduct behavioral and eye-tracking experiments to measure the viewers' response and incorporate those observations in our model.

Acknowledgments

References

Barnden, J.A., & Holyoak, K.J. (Eds.) (1994). *Analogy, Metaphor, and Reminding,* Intellect Books.

Dali, S. (1993). *The Secret Life of Salvador Dali.* New York: Dover.

Dunbar, K. (1997). How scientists think: On-line creativity and conceptual change in science. In T.B. Ward, S.M. Smith and J. Vaid (Eds.), *Creative thought: An investigation of conceptual structures and processes.* Washington, DC: American Psychological Association.

Faries, J.M., & Schlossberg, K.R. (1994). The effect of similarity on memory for prior problems, *Proceedings of the 16th annual conference of the Cognitive Science Society,* 278 – 282.

Fauconnier, G., & Turner, M. (2002). *The Way We Think: Conceptual Blending and the Mind's Hidden Complexities.* New York: Basic Books.

Gordon, W.J.J. (1961). *Synectics: The Development of Creative Capacity.* New York: Harper & Row.

Hofstadter, D. (1995). *Fluid concepts and creative analogies: Computer models of the fundamental mechanisms of thought.* New York: Basic Books.

Indurkhya, B. (1997). On Modeling Creativity in Legal Reasoning. *Proceedings of the Sixth International Conference on AI and Law,* 180-189. Melbourne, Australia.

Indurkhya, B. (2006). Emergent representations, interaction theory, and the cognitive force of metaphor. *New Ideas in Psychology, 24(2*), 133–162.

Indurkhya, B. (2007). Creativity in Interpreting Poetic Metaphors. In T. Kusumi (Ed.) *New Directions in Metaphor Research,* Tokyo: Hitsuji Shobo, Tokyo.

Indurkhya, B. (2010) On the role of metaphor in creative cognition. *Proceedings of the International Conference on Computational Creativity: ICCC-X,* Lisbon, Portugal.

Indurkhya, B., Kattalay, K., Ojha, A., & Tandon, P. (2008). Experiments with a creativity-support system based on perceptual similarity. In H. Fujita and I. Zualkernan (Eds.) *New Trends in Software Methodologies, Tools and Techniques,* Amsterdam: IOS Press.

Jia, L., Hirt, E.R., & Karpen, S.C. (2009). Lessons from a Faraway land: The effect of spatial distance on creative cognition. *Journal of Experimental Social Psychology 45,* 1127–1131.

Koestler, A. (1964). *The Act of Creation.* London: Hutchinsons.

Kokinov, B., Holyoak, K. & Gentner, D. (Eds.) (2009). *New Frontiers in Analogy Research,* Sofia: New Bulgarian University Press.

Mace, M., & Ward, T. (2002). Modeling the creative process: A grounded theory analysis of creativity in the domain of art making. *Creativity Research Journal 14,* 179–192.

Ogawa, S., Indurkhya, B., & Byrski, A. (2012). A meme-based architecture for modeling creativity. *Proc. of the Int. Conf. on Computational Creativity,* Dublin, Ireland.

Ojha, A., & Indurkhya, B. (2009). Perceptual vs. conceptual similarities and creation of new features in visual metaphor. In B. Kokinov, K. Holyoak & D. Gentner (Eds.) *New Frontiers in Analogy Research,* Sofia: New Bulgarian University Press.

Ojha, A., & Indurkhya, B. (2012). On the role of perceptual features in metaphor. To appear in F. Ervas & E. Gola (Eds.) *Metaphor and Communication.*

Okada, T., Yokochi, S., Ishibashi, K., Ueda, K. (2009). Analogical Modification in the Creation of Contemporary Art. *Cognitive Systems Research 10* (3), 189–203.

Rodari, G. (1996). *The Grammar of Fantasy* (J. Zipes, Trans.) New York: Teachers & Writers Collaborative.

Sawyer, K. (2006). *Explaining Creativity.* Oxford (UK): Oxford University Press.

Schön, D.A. (1963). *Displacement of Concepts.* New York: Humanities Press.

Shapira, O., & Liberman N. (2009). An Easy Way to Increase Creativity. *Scientific American (Mind Matters),* July 21, 2009.

Stokes, P.D. (2005). *Creativity from Constraints: The Psychology of Breakthrough.* Berlin: Springer.

Ward, T.B. (2011). Analogies. In M.A. Runco & S.R. Pritzker (Eds.) Encyclopedia of Creativity, (2nd ed.), New York: Academic Press.