Creativity, Learning and Risk Orientation

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The paper attempts to explore the cognitive mechanism and offers an underlying framework that can integrate the various perspectives on creative thinking. In doing so, it shows that creativity and learning are two different aspects of a single underlying process which are directly related to individual’s risk orientation. The paper aims to contribute to the literature by showing how an individual’s creativity, learning and risk orientation are connected and their unifying framework manifests differently under a change in conditions under which the thinking process is carried out.

The creative mechanism has been defined as the Darwinian process of blind variation and selective retention (Campbell, 1960; Simonton, 2005). At the same time, the creative process is also explained as Non-Darwinian flow of ideas (Weisberg & Hass, 2007; Gabora, 2007). The common theme amongst these views is that concepts are distributed at various locations in the cognitive schema and may be uniquely associated for the generation of novel and useful ideas (Rothenberg, 1979; Ward, 2001; Amabile, 1996). Similarly, learning is identified as a long-term change in the cognitive pattern of associations that can be used to function more effectively in other related situations (Shuell, 1986).
It is convenient to classify ideas generated in the mind into two types: ideas that are new to the individual as well as new to the world (NTIW), and ideas that are new to the individual only (NTI). In most cases, a new form of creative association by an individual may lead to a revolutionary solution and the creator is recognized, while in other cases, it may just be a matter of time until it is found by the individual that the idea was already discovered by someone earlier than him. While the usual approach to such creative insights is to give credit to the first person who identified a novel idea, in terms of the creative potential all such individuals lay at the same level. Furthermore, the process of learning is nothing but an attempt to re-create such NTI concepts to emulate what has already been found by others; which is very clear if its takes place under the direction of an external agent such as a teacher.

Cognitive Approaches and Processing

There are several approaches towards the deployment of the cognitive mechanism, varying in the extent of the use of cognitive process and include:

a) Revisit: This is the recall from memory whenever there is a need to redo whatever has been done in the past and happens when an experienced person attempts to repeat exactly what they have been doing without any changes. It requires the least cognitive power as no new thinking is needed. An example is an individual
carrying out oil change in their car who has done it for the last five years since they purchased it.

b) Recreate: This is when an association process is being carried out with a fair idea of what concepts need to be associated and the expected result. This happens when a person does not remember something that they thought or did earlier or when they have been told to do something in detail but are attempting it for the first time. Such a case results in the person having a fair idea of what concepts need to be combined, but their exact order and associations may not be clear for the complete length of the task (discussed further in trajectory). This leads to the development of newer associations in addition to retracing some existing ones and requires a moderate level of cognitive processing. For example, when an individual gets to change the oil for their new car for the very first time, some new associations are formed even though changing oil may not be a new experience. It may be due to difference in the structure of the car, the change in the oil filter, or it may be the sequence of turns required to pull the filter out that may be different for various models.

c) Create: This is the creation of an entirely new set of associations and happens during the learning of a new concept, thinking about a new problem or identifying a new approach towards an existing problem. While this requires the most amount of cognitive processing, it further depends upon the clarity of domain, end points and trajectory which are discussed later. For example, when an individual
gets to change the oil in a car for the very first time in their life, the very act
requires a lot of newer associations between concepts that may not have been
associated before, such as lying down, being dirty, taking out a used filter, etc.
While this may have been made more predictable based on individuals’
observeration of this process in the past, the extent of predictability of each motion
following the next is a function of the detailed memory of the previous
observations and in certain cases, may turn more into an act of recreation than of
creation.

Of the three approaches, creativity supersedes recreation and revisitation since it is only
when certain associations are established that they can be reviewed and remembered and
therefore the discussion below is focused on the creative process. However, it underlies
all the three and some of the examples will touch upon them in order to clarify the
differences.

**Cognitive Mechanism**

The cognitive mechanism of association of concepts can be grouped into the two
categories, each of which is divided into further components:

A. Governance: This controls the pattern of associations between previously independent
concepts and comprises of three components:
1. Control

The cognitive processes are working at all times. However, the process may be controlled (as in conscious thinking) or uncontrolled (as in dreams) in order to determine the manner in which concepts are combined (Simonton, 2005). The conscious acts as the governance mechanism and either controls the cognitive process or relinquishes the control; the extent of which lies along a continuum. The three levels of controls particularly important for discussion along this continuum include:

a) Complete Control:
   a. Externally driven: This is the learning mode when an individual is in a classroom environment and the entity driving the cognitive association process is external, the teacher, while the control lies with the conscious.
   b. Internally driven: This is when the individual is involved in thinking on their own while focused on a task. The driver and control both lie with the conscious.

b) Partial Control:
   a. Externally driven: When an individual is trying to control the process and align it with an external entity but at the same time is limited by factors that inhibit complete control of the cognitive process due to some reason.
An example is when a person is attending a lecture while being really sleepy. Their cognitive process cycles through a combination of controlled and uncontrolled phases (and is usually visible in their grades).

As soon as the control phase starts, the conscious shifts attention from internal thinking processes to the external teacher. As the conscious starts losing control, momentarily the external driver is replaced by the internal processes before the unconscious takes over. The cycle repeats itself when the conscious gets back into control.

b. Internally driven: when the internal control is deliberately relaxed in order to give rise to uncontrolled cognitive associations. This may happen when we are busy with an activity that does not consume most of the cognitive powers, leaving ample room for it to run off on its own, every now and then tapped by the conscious for alignment (further discussed in goals). Achievement of this state is the aim of most brain-storming sessions.

c) No Control:

In this case, there is no driver or governance and the process runs off on its own. This is what happens when we are dreaming in our sleep. Although some cues can define the domain of associations (discussed later) or the kind of elements that we will get to visualize in our dreams, the mechanism and speed of associations is uncontrolled. This is also the
default level when there is no pressure to control the mechanism and turns into the random wandering state.

The various levels of controls can be understood as the pull on a flexible string tied between two randomly vibrating end-points, from its center. Complete control of the cognitive process is like a pull that is very strong and completely limits the vibration pattern to no random fluctuations. A partial control is similar to a slightly lighter pull that leaves some freedom of movement to the string that allows formation of only a certain restricted movements. No control scenario is similar to no external pull and completely leaves the string to wobble on its own random way.

2. End-Point

This defines the clarity of the result expected from the cognitive process. Similar to control, there is a continuum along which lay individuals’ clarity of the end-point, of which the three key levels are:

a. Explicit: A very clear end-point is the clear understanding of what needs to be achieved. It is usually difficult to understand the end-point unless the path (trajectory) as well as the domain of concepts is clear, as discussed later. However, there may be instances when the end-point is explicit but the trajectory and domain are not clear. For example, an inexperienced person even after knowing the end-point may adopt an unexpected trajectory and/or end up using an
unexpected domain. This may be visible from the number of oil splashes on a person who has just changed oil in their car who knows that to do (end-point) but not exactly what tools and skills to use (domain of association) and how exactly to carry out the process (trajectory).

b. Hazy: This is when the expected end-point of the cognitive process is not so clear. In such situations, the number of potential associations is large. A good example is when an individual is told to find out why is the car leaking oil. Various people will go through different ways of tracing the problem and may even arrive at different results. In the case of car leaking oil, there are usually a very few possibilities, but for complex problems, there may be a very large range of trajectories that can bring close to the final but hazy end-point. The haziness of the end-point can be diminished by identifying the last few associations that lead to the end-point. In this case it may be to identify why the car is leaking oil whenever it speeds over 60 mph.

c. None: In the absence of an end-point, the number of possible paths becomes infinite and even when the process is completely controlled by the conscious, the lack of an understanding of the end may result into the cognitive mechanism attempting wild associations. On one end, this is an example of induction based logical thinking when the gradual unfolding of the path based on available information identifies an end-point. This happens when a graduate student at the
The end of the month is looking at the few ingredients in the corner of the refrigerator to identify if something can be cooked out of them. The absence of the end-point may be because the individual doesn’t know about it or because it is far too unusual for them to be able to relate to it. The latter is visible when a teacher asks a question in the very first class over something that is entirely new to the students. If they decide to speak up, they answers will end up forming a very wide range of possibilities.

3. Trajectory

This is the actual path of conceptual associations that need to be followed under the governance and includes the order of combining concepts as well as the sequence of those combining associations, which can be called the latitudinal and longitudinal associations, respectively.

a. Precise: A trajectory is precise when the path is highly patterned with the individual so that no other latitudinal or longitudinal association can be imagined. This happens often when the person is very experienced in a certain area when they know exactly the associations their sequence in order to get something done. In the presence of an end-point all the relevant paths are conjured up in the mind with the ones most frequented listed as the optimal trajectory. Even in the absence of an end-point, being told about the trajectory may bring the image of what may be the logical end-point. Thus, a precise trajectory limits the possibility
of creative output, which is precisely what is attempted for measurement in the various tests of creative potential.

b. Vague: In the absence of obvious paths towards an end-point for the individual, the trajectory is vague. This may be due to the lack of experience, knowledge, etc. but at the same time, may be the result of absence of preconceived ideas of what leads to certain end-points. An example is Galileo’s experiment of measuring the speed of fall for heavier and lighter objects when people believed that heavier objects obviously fall faster than the lighter ones. Galileo’s capacity to view multiple trajectories towards the an end-point of gravitational attraction, which included looking for the attraction to be a function of the mass, size or shape of a body, allowed him to find a better understanding that was missed by the scientific community at that time who had a single dominant trajectory of thinking about the falling of objects towards earth.

Thus, a vague trajectory increases the chance of creative output, but, the lack of decision on an optimal path implies lack of preferences or experience. While understanding of preferred trajectories is essential, new approaches to solving a problem can only come with experimentation of newer trajectories. The creative problem solving attempts on varying the trajectory towards an end-point. While this is easily possible for a person from a different background when exposed to a problem in a certain field (provided the end-point is clear, otherwise, they will work away into entirely different directions), the people within the field can approach it by
gaining more knowledge about other areas that may be able to help them with expanding their repertoire of trajectories. Experience can decrease the range of trajectories if allowed to optimize over time, but can increase the range if the individual keeps on working on bringing into consideration other possibilities through acquisition of more knowledge, openness to experience, etc.

In the case of a revisiting approach, every association is predicted in advance as well as the next set of associations. The cognitive process of association is already established and the script is just being read from memory.

In the case of a recreation approach the trajectory is slightly unpredictable. It is predictable where the association possibilities are either very clear or have fewer options given the knowledge (or experience) of the individual. In such a case, the element of unpredictability only arises when the path to be followed is not clear or the knowledge does not align with the path being followed. This happens for example when one is driving through a different part of the city towards home while using a GPS. There is some level of unpredictability or blindness in terms of unfolding of the trajectory. Even though they may be comfortable using the GPS, they are not sure about the kind of turns on the road they’ll need to take. Each additional piece of knowledge provides more associations along the trajectory.

In the case of a creative approach, there is no pre-defined optimal path for the cognitive mechanism to follow. The trajectory is developed from random trial and
error (Simonton, 2005) or may be a result of some previous knowledge which allows one or more optimal trajectories towards the desired end-point (Weisberg and Hass, 2007). In either case, there is some sort of blindness in predicting the way associations will take place . . . the greater the unpredictability, the greater the blindness (Simonton, 2007). However, experience will tend to reduce blindness by biasing the process to select the path of associations that have worked in the past, in moving the process in the desired direction (Simonton, 2004). When the end-point is not so clear, experience is less of a help and so the blindness increases giving rise to even more trial and errors, as discussed earlier.

B. Domain of Association

The ranges of potential concepts that can be combined together define their domain. Again, while this forms a continuum, the extreme ends include:

a) Narrow: This is when a smaller domain of potential concepts is available for combination. In a controlled process, the domain is typically defined by the problem at hand. For example, in a classroom, this is a result of the expectations of the student and principally the teacher is responsible to extend the domain gradually so as to not surprise the student by suddenly breaching the expected boundaries of their domain of association. People who have been working in a field for a long time are used to limiting the domain to a set of certain concepts
and therefore find it more difficult to create newer associations even though they may be driven by an external entity, such as when attempt to innovate for newer products (Schooler & Melcher, 1995). However, certain professions lead to an increase in the domain of potential associations with experience, such as artists who have worked on several paintings or a teacher who has worked with different teaching methodologies. Thus, experience may increase or decrease the domain of associations, depending upon the profession.

b) Wide: This is when the potential range of concepts available for possible combination is large. With every increase, there is a corresponding increase in the range of possible trajectories until the optimal paths are selected and memorized.

Creativity in this context can also be defined as an association of concepts that includes elements from a domain while in addition to a free floating search for others that can be meaningfully combined to produce the desired end-point. Domain of associations lead to what Mednick (1962) has identified as the hierarchy of associations; steep hierarchies indicating a narrow range of associations while a flat or wider hierarchy reflecting a greater possibility of remote associations and therefore of creative output.

In the absence of an end-point, the range of associations in an internally driven process is much wider and may lead to unexpected results. This, as discussed earlier, is easily possible in an uncontrolled process, sometimes possible in partially controlled process, is
almost impossible in a controlled process. This is because the domain is defined by the same entity (the conscious) as the entity controlling the association process. As the association process starts moving into newer directions, the conscious opens up the domains associated with these newer domains and therefore a carefully thought out process will have less of a surprise for the individual. A totally uncontrolled association process will sweep through a very wide range of domains and therefore will not only include surprises, but also non-sense possibilities as we often see in our dreams.

The domain of associations is a function of individual’s knowledge (and environment) in the controlled phase. An example includes the concept “sandwich” that can be easily associated with the concept of “food” but not with “feet” unless logically explained by someone else or observed through some product that connects them together. However, in the partially controlled phase it is a function of individual’s personality, specifically, their openness to experiences or risk orientation. For individuals with a greater openness to new experiences, the domain of association will even include weakly connected domains (Dollinger, 2007; McRae, 1987). An example for a person with high openness includes the possibility that they will be able to combine the concepts of “sandwich” and “feet” and may come out with sandwich shaped shoes or feet shaped sandwiches, etc. This is clearly a representation of an individuals creative potential and is measured through the various divergent thinking tests (Guilford, 1950; 1967).
## Conclusion

The above discussion is summarized in the following figure which shows that learning, logical thinking and problem solving fall into completely controlled processes while creative thinking requires partially controlled processes in addition to some other examples for the various possible combinations of the cognitive elements. Moreover, the greater an individual’s openness to experience and therefore risk orientation, the greater is the range of associative domains available for combination and therefore greater the possibility of creative output.

<table>
<thead>
<tr>
<th>Control</th>
<th>End-point</th>
<th>Trajectory</th>
<th>Domain</th>
<th>Example: Externally Driven</th>
<th>Example: Internally Driven</th>
</tr>
</thead>
<tbody>
<tr>
<td>Complete</td>
<td>Explicit</td>
<td>Precise</td>
<td>Narrow</td>
<td>Working on something through memory</td>
<td>Learning in a classroom environment</td>
</tr>
<tr>
<td>Partial</td>
<td>Explicit</td>
<td>Precise</td>
<td>Narrow</td>
<td>Sleeping during a lecture</td>
<td>Frequent distraction while studying</td>
</tr>
<tr>
<td>Complete</td>
<td>Explicit</td>
<td>Vague</td>
<td>Narrow</td>
<td>Frequent distraction while studying</td>
<td></td>
</tr>
<tr>
<td>Partial</td>
<td>Explicit</td>
<td>Vague</td>
<td>Narrow</td>
<td>Frequent distraction while studying</td>
<td></td>
</tr>
<tr>
<td>None</td>
<td>Explicit</td>
<td>Vague</td>
<td>Narrow</td>
<td>Frequent distraction while studying</td>
<td></td>
</tr>
<tr>
<td>Complete</td>
<td>Hazy</td>
<td>Vague</td>
<td>Narrow</td>
<td>Hearing gossip about a close friend</td>
<td></td>
</tr>
<tr>
<td>Partial</td>
<td>Hazy</td>
<td>Vague</td>
<td>Narrow</td>
<td>Watching a boring show on television</td>
<td></td>
</tr>
<tr>
<td>Partial</td>
<td>Hazy</td>
<td>Vague</td>
<td>Wide</td>
<td>Watching a boring show on television</td>
<td></td>
</tr>
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</tr>
</tbody>
</table>

## Modeling

A basic model of the above discussion is developed using Netlogo where each bit of cognitive information (or concept in the language of this paper) is listed as a unique word from the English language. The model is an algorithm for random associations between these concepts which are filtered by the openness to risk for the person. The model shows that the only those random associations appear in the conscious which are within
the bound of openness to risk by the individual. If the individual’s openness to risk is increased, it increases the number of concepts fulfilling this criterion to appear in the conscious.

During each iteration the model increases the number of associations by one as well as decreases them by one. This emulates the effort of cognitive processes to continuously make meaning out of newer observations by creating associations in the presence of disturbances such as memory loss. It can be seen that the random combinations form a curve which is similar to the learning curve associated with individual’s understanding of newer concepts. However, since the model does not stop after maturity of the learning curve and the associations keep going on, every now and then there is a greater learning visible by some peak that improves the level of understanding further through newer associations. This reflects a heightened understanding, insight or the emergence of a creative idea.
References


