Running Head: FROM WALLS TO WINDOWS: USING BARRIERS AS PATHWAYS TO INSIGHTFUL SOLUTIONS

Abstract

The purpose of this study was to explore and develop a conceptual model for how individuals unlock insight. The concept of insight - the 'out of the box' or 'aha!' solution to a problem - offers a framework for exploring and understanding how best to enhance problem solving skills due to the cognitive shift insight requires. Creative problem solving (CPS) is inherent to a variety of performance realms including effective decision making, innovation, and organizational development; however, related processes of insight, innovation and creativity remain intangible. The model, based on a review of the problem solving literature, proposes that insight involves a five stage, cyclical process emerging as: primary appraisal of the problem, secondary appraisal based on prior knowledge, initial focus, problem representation, and solution generation when, if no solution is found, the cycle begins again. The research has implications for individual, team and organizational settings suggesting that performance on a wide variety of problems may be improved by utilizing an integrated focus rather than a barrier or goal focus alone.

Keywords: insight, problem solving, creativity, decision making, problem finding

From Walls to Windows:

Using Barriers as Pathways to Insightful Solutions

The concept of insight - the 'out of the box' or 'aha!' solution to a problem - offers a framework for exploring and understanding how best to enhance problem solving skills and, consequently, performance in a variety of realms. The sudden shift in thinking that characterizes the insightful solution seems to be an important link in unlocking creative solutions to all manner of problems. Researchers of insight problem solving argue that the cognitive shift we seek happens not at the solution end of the problem, but at the problem end. It is believed that insight results from a restructuring or redefinition of the problem (Knoblich et al., 1999; Ohlsson, 1986) which leads to the abrupt and unanticipated change in the solution path that leads the solver to immediate success with a problem (Weisberg, 1995). As the old adage says: a problem well defined is half solved. As such, Wertheimer describes insight as a 'new, more penetrating view of the problem', but what does 'a more penetrating view' really mean? And how does one go about achieving 'a more penetrating view'?

An historical example of creative insight occurred within the Mann Gulch fire of 1949 and demonstrates aspects of the insight problem solving process. Mann Gulch occurred when a wildfire in the Helena National Forest, Montana, United States, spread out of control and ultimately claimed the lives of 13 firefighters. Foreman Wagner Dodge led the team towards the Missouri River. The fire, however, spread faster than anticipated and had already cut off their path to safety. The men had to turn around but the fire was quickly gaining on them. When Dodge realized that they would not be able to outrun the fire, he started an escape fire and motioned amidst the roar of the flames for everyone to lie down in the area he was about to burn down. The other team members, thinking him crazy, hurried towards the ridge of Mann Gulch

instead (achieving heroic speeds in their desperate attempts to escape!). Only two of them, Bob Sallee and Walter Rumsey, managed to escape through a crevice and find a safe location - a rock slide with little vegetation to fuel the fire. Two other members survived with heavy injuries and died within a day. Only Dodge had the insight to remove fuel so as to reduce the chance of being burned by the fire. Ironically the two other survivors benefitted from the same principle that Dodge applied in his solution: though they reached it purely by chance, the rocky slope they reached had no fuel for the fire. Insight appears to require the ability to 'shake loose' from assumptions and prior knowledge (that the problem was 'how to outrun or escape the fire') but, perhaps most importantly, the ability to clearly define the problem ('how do we avoid being burned by the fire?').

This study views insight as a critical component to the creative problem solving process. Creative problem solving (CPS) is an important component of high performance in a variety of realms. The capacity for CPS is inherent to effective decision making, innovation, and strategic planning (Ketchen, Snow & Street, 2004; Nutt, 2002, 2004; Vance, Groves, Paik & Kindler, 2007), as well as individual physical, artistic, and mental tasks (Durand-Bush & Salmela, 2002; D'Zurilla, & Sheedy, 1992; Kovác, 1998; Pugh, 1991; Smith, Carlsson, Sandström, 1985; Wang & Horng, 2002; Wanish, 2000); however, the creativity and insight involved in the creative problem solving process remain intangible concepts. Discussion abounds as to what creative problem solving involves (Callahan, 1991; Khatena, 1982). Those familiar with the recurrent waves of interest in the field will note an emerging framework that emphasizes divergent thinking coupled with convergent thinking (Cropley, 1999; Runco, 2004). Divergence, or 'out of the box' thinking seems to have begun with the father of brainstorming, Alex Osborn (1963). However, others have since added to the literature on divergent thinking including:

- Bill Gordon (1956; 1961) and George Prince (1970) and their Synectics approach which attributes creativity to connection-making
- Edward deBono (1971) and the Six Hats or Lateral Thinking approach in which creativity is described in terms of new ideas *and* new perceptions
- Isaksen and Treffinger (1985) and Isaksen and Dorval (1994) who focus on evaluating ideas using a Criterion Matrix
- Rickards (1990) who explores intuitive and structured techniques for 'choosing wisely'

Recently, Chrysikou (2006) found significantly positive results in training participants to think divergently about the nature of the problem as well as elements of the problem itself in order to 'shake loose' constrained thinking and unlock creative solutions. But, while divergence – the ability to generate more creative ideas or 'shake loose' from in-the-box thinking – can be useful at both the problem and solution end of the problem solving process, it is also important to 'converge' or 'choose wisely' from among a variety of alternatives. In general, researchers have come to agree that training CPS involves facilitating both divergent and convergent thinking skills, but it is unclear in what order or to what extent. As well, we must be careful not to confuse creative problem solving with creative thinking. While a certain amount of creative thinking may facilitate problem solving, a creative solution is not necessarily the best, most insightful, solution.

Those who emphasize the importance of 'problem finding' suggest that the key to unlocking creative solutions lies in the reverse combination of divergence and convergence, arguing that convergence comes first. Determining what constitutes a wise solution demands convergence upon the true nature or definition of the problem followed by the divergent generation of solutions (Basadur et al, 1982, 1992, 2000a; Kershaw & Ohlsson, 2004; Rickards

& Puccio, 1991; Runco & Chand, 1994; Volkema, 1995). Volkema (1995) cites the Challenge Shuttle disaster when explaining the importance of problem formulation as a means to effective problem solving:

> Preceding the fatal launch, there was considerable discussion regarding the technical performance of Challenger's O-rings in cold temperatures. Key decision makers, however, were concerned about several previous launch delays and about jeopardizing other scheduled missions. Furthermore, political support for the space shuttle program could be bolstered if the launch was to coincide with the president's State-of-the-Union message. The problem quickly became how to convince those engineers concerned with the O-rings to go along with the launch, the corrupting lie, rather than exploring ways to gain favorable publicity and ensure future missions (p. 82-83).

Because problem formulation is an important component of the creative problem solving process and the phenomena of insight depends upon problem formulation, insight represents a productive pathway of exploration. How one arrives at or changes one's definition of a problem remains elusive. Therefore, the purpose of this literature review was to explore and develop a conceptual model for how individuals unlock insight. The guiding questions for the study were (1) What differentiates one problem definition from another? and (2) What impedes or enables a problem solver's ability to formulate a problem in a way that solves the 'right' problem and results in a creative breakthrough as opposed to a 'corrupting lie'? The study drew upon theories of cognition and information processing and sought to enlarge the theory of problem solving by building upon the restructuring (Mumford et al., 1994; Ohlsson, 1996) and constraint relaxation literature (Knoblich et al., 1999).

PROBLEM SOLVING AND CREATIVE INSIGHT: A REVIEW OF THE LITERATURE

Insight is of particular interest due to implications for related areas of creativity, learning, and performance. For instance, the divergence, openness, looseness, or 'breadth of attentional focus' typical of the creative thinker is enhanced further with the unlocking of insight into the nature of

the problem and would be quite useful in a number of performance realms. Various explanations share the view that the locus of insight difficulty is centered on the solver's constrained representation or formulation of the problem, though each points to different constraints (prior experience, perception, and assumptions) (MacGregor et al., 2001). If generating sustainable solutions depends upon how the problem is defined, it is important to understand the process of problem formulation and its consequences for the problem solving process as a whole. Building upon the current theoretical framework surrounding insight, the following section reviews the literature on the topics of: the nature of insight, the insight process, obstacles to insight, and how insight may be facilitated.

The Nature of Insight

Creative problem solving requires a certain shift in thinking or letting go of assumptions about the problem and its potential solutions at the same time as it requires a sudden clarity of problem definition characterized as insight or the 'aha' moment. Many cognitive psychologists agree that insight plays a necessary role in the development of creative solutions (Dominowski, 1995; Ohlsson, 1992; Knoblich, Ohlsson, Haider, & Rhenius, 1999; Schooler & Melcher, 1995; Sternberg & Davidson, 1995; Sternberg & Lubart, 1996). For Schooler, Ohlsson, and Brooks (1993), the insight problem solving process involves:

> a) a solution well within the competence of the average subject;
>
> b) a high probability of an 'impasse', that is, a state in which the subject does not know what to do next; and
>
> c) an 'Aha!' experience resulting from sustained effort in which the impasse is suddenly broken and insight into the solution is rapidly attained.

As well, the insightful solution seems to differ from a merely creative solution or idea by being sustainable, systemic, and somewhat elegant. For instance, in the Mann Gulch example, a creative solution would be to 'airlift' the firefighters out of danger, but this solution is not systemic as it does not take into consideration all aspects of the problem. For one of the problems in the study, the challenge was to secure a screw in a too-large hole. A creative solution would be to jam a screwdriver into the hole to make it smaller, but this is not sustainable or elegant because the screwdriver might fall out, and besides, who would want a screwdriver sticking out of their living room wall? The NASA example needed a systemic solution that took all stakeholders into account.

There exist a number of examples of creative insight from which we can gain a more thorough understanding of the insight process:

Example 1: An example of insight occurred within NASA during the early days of the space program. Scientists tried to solve the problem of heat of re-entry by devising a substance that could withstand heat, and met with repeated failure. Their ultimate solution – the ablative heat shield that burns away as the space vehicle penetrates the atmosphere, taking the heat with it – turned upside down their original problem definition of 'how to withstand the heat.'

Example 2: A large healthcare facility was operating with success in a large urban centre (Caldwell et al., 2007). The centre employed over 1000 doctors and several thousand nurses and staff. A smaller health center opened within the same area, offering good care at a reduced rate, and soon lured a good portion of the clientele away from the larger centre. One can imagine the implications that attempting cost cutting would have upon both employee and client satisfaction. A more insightful solution found the larger centre focusing instead upon quality. Their new

mandate of offering ‘quality care at a moderate rate’ found commitment from organizational members and was implemented over 2 years with a positive response from clientele.

These examples suggest that the sustainable solution is one that shows insight by illustrating a profound understanding of the problem at its core, and sustainability by offering a practical and enduring application that is systemic in nature.

The Insight Process

The insightful problem-solving process has been proposed to involve three main phases (Schooler, Ohlsson, and Brooks; 1993):

a) an initial *representation* phase, in which the solver inappropriately represents the problem

b) an initial *search* through the faulty problem space that may lead to *impasse*

d) and a post-impasse *restructuring* phase.

There are gaps in the research concerning what factors might influence both the representation and the restructuring phases and how these factors may be facilitated more effectively to produce an insightful solution.

Problem Representation

If a problem solver develops a correct representation of a problem, the relevant operators will be activated. Getzels (1982) coined ‘problem construction’, Mumford and colleagues (1994) introduced ‘problem representations’, and Keeney (1982) and Volkema (1997) ‘problem formulation’. Many have experienced the phenomenon in which one has a problem and goes about searching for something to fix the problem. Or, in the words of one colleague, “I don’t know what I am looking for but I know it is somewhere on this workbench.” Getzels (1975)

provides an excellent illustration of how problem construction sets the problem solver up for insight:

> An automobile is traveling on a deserted country road and blows a tire. The occupants of the automobile go to the trunk and discover that there is no jack. They define their dilemma by posing the problem: "Where can we get a jack?" The look about, see some empty barns but no habitation, and recall that, several miles back they had passed a service station. They decide to walk back to the station to get a jack. While they are gone, an automobile coming from the other direction also blows a tire. The occupants of this automobile discover that they have no jack. They define their dilemma by posing the problem: "How can we raise the automobile?" They look around and see, adjacent to the road, a barn with a pulley for lifting bales of hay to the loft. They roll the automobile to the barn, raise it on the pulley, change the tire, and drive off (p. 38).

How solvers represent the problem determines the solution path. The way in which the two groups constructed the problem (i.e. we must have a jack to solve this problem vs. we must raise the car somehow to solve this problem) confirms that though various explanations point to different constraints (prior experience, problem display, assumptions), all share the view that the locus of problem difficulty is centered on the solver's constrained representation of the problem (MacGregor et al., 2001).

Problem Search and Impasse

Problems demanding insight all seem to possess an impasse or a point at which the problem solver gets 'stuck'. Solvers meet with impasse when they have incorrectly represented the problem. For instance, in the NASA example above, the impasse seemed to occur at the realization that 'there is no material that can withstand the heat.' Breaking through an impasse requires insight into the true nature of the problem. Breaking through the NASA impasse required that the engineers consider moving beyond the goal of 'heat tolerance' and toward 'heat absorption.' Problem solving often unfolds in a way that reflects the need to overcome the imperatives of past experience. The thinker begins by exploring the approaches to the problem

suggested by past experience. When success does not follow, he or she enters an impasse, a state of mind that is accompanied by a subjective feeling of not knowing what to do and the cessation of overt problem-solving behaviour (Ohlsson, 1992). Theorists suggest that breaking the impasse may demand a restructuring of the problem representation or a relaxing of cognitive constraints.

Problem Restructuring

Continued attention to the problem sometimes leads to restructuring and the appearance of a new idea, solution, or approach in consciousness. If the restructuring turns out to be unhelpful, the impasse continues. However, if the new idea does point the way to a solution, goal attainment is likely to be purposeful and swift, in marked contrast to the hesitation and passivity of the impasse phase (Knoblich, Ohlsson, Haider, & Rhenius, 1999). Several researchers in creative problem solving suggest that restructuring or the formation of a new representation of the problem is the only manner by which activation can be redirected (Ohlsson, 1984;1992). Some theories propose that the restructuring phase involves controlled search processes (Davidson, 1995; Kaplan & Simon, 1990), whereas other theories propose that restructuring is achieved through the automatic redistribution of activation in long-term memory (Ohlsson, 1992; Seifert, Meyer, Davidson, Patalano, &Yaniv, 1995) and constraint relaxation (Knoblich, & Haider, 1996; Knoblich, Ohlsson, Haider, & Rhenius, 1999). Many have suggested ways to achieve a new view of the problem (Clement, 1982, 1991; Newell and Simon, 1972; Schoenfeld, 1982; Schoenfeld and Hermann, 1982). While helpful, creative idea generation, divergence training, or simply 'shaking loose' from one's problem representation is not specific enough to lead to an insightful solution. Wertheimer (1959) articulated well the challenge we face in attempting to train creative problem solving: insight results from not only a new view of the problem but the sudden realization of 'a new, more penetrating view of a problem situation'. It seems that true insight

involves insight into the nature of the problem. It remains unclear how to go about restructuring a problem representation in a way that is insightful.

Obstacles to Insight

Exploring obstacles to insight and what is believed to be happening within the impasse stage may illustrate how a more insightful representation of the problem may be facilitated. Though theories abound, what happens between the impasse and 'aha!' moments remains a mystery to insight researchers. Kershaw and Ohlsson (2004) distinguish three classes of difficulty factors in solving insight problems: prior knowledge, perception of the problem, and processing of the problem information.

Prior Knowledge

Prior knowledge or the experiences, beliefs, and assumptions that individuals bring to a task, can support or constrain insight and the problem solving process in general. Familiarity with or prior knowledge of the problem components should hypothetically enhance participants' performance (i.e. knowledge of mechanics would assist a person in fixing a car problem). Alternatively, it could be argued that familiarity may breed 'fixation' (Dominowski,1981) and lack of creativity (i.e. assuming that a brick can only be used for building). Successful experiments, begun as early as the 1920s by Gestalt psychologists Karl Duncker (1941) and, later, Abraham Luchins (1942), demonstrated that habitual use of familiar objects and problem-solving strategies limits the ways individuals employ them. Psychologist Jennifer Wiley (1998) revived Duncker and Luchins' work with a study investigating the relation between expertise and blindness to alternatives. Wiley found that "experts generally solve problems in their fields more effectively than novices because their well-structured, easily activated knowledge allows for efficient search of a solution space" (p. 716). Subjects with a large amount of domain knowledge may actually be at a

disadvantage because their knowledge may confine them to an area of the search space in which the solution does not reside.

Prior experience can lead a solver to make assumptions about the nature of the problem which are inappropriate and constrain the problem representation leading to a faulty search and impasse. Hashem, Chi and Friedman (2003) found that physicians within a given specialty have a bias in diagnosing cases outside their own domain as being within that domain and try to 'pull' cases toward their specialty. In this way, domain knowledge may act as a mental set, promoting fixation in problem solving attempts. In previous work, Ohlsson (1992) proposed that past experience or prior knowledge biases the initial analysis and interpretation of a problem or a situation in particular ways. The initial interpretation constructs a problem representation which then activates potentially useful knowledge elements (categories, chunks, concepts, constraints, methods, operators, procedures, rules, schemas, etc.). These knowledge elements implicitly define a space of possible solutions. If past experience is not helpful vis-à-vis the problem, that initial problem space does not contain a workable solution and an impasse will result.

Perception

Gestalt theory would suggest that problem representation is constructed based on a number of factors that influence an individual's perception. Max Wertheimer, together with Kurt Koffka and Wolfgang Köhler, was the founder of Gestalt theory. In his (1912) 'Experimentelle Studien über das Sehen von Bewegung' he examined the phenomenon of apparent motion, where a pair of alternately flashing lights stimulate a perception of a single light moving back and forth. Wertheimer recognized that this phenomenon revealed a constructive or generative aspect of perception. DeBono (2005), father of lateral thinking, argued that "the majority of mistakes in ordinary thinking (outside technical matters) are mistakes in perception. Our traditional emphasis

on logic does little for perception. If the perception is inadequate, no amount of excellence in logic will make up for that deficiency". Perception is biased by prior knowledge and appraisal. How one appraises the problem determines how one might go about representing the problem which in turn determines how one might go about searching for and seeing potential solutions.

How one represents or defines the problem (we need a jack vs we need to raise the car) determines attentional focus (focusing on finding a jack vs. focusing on raising the car). Focus in turn determines the degree and kind of cognitive constraint (only a jack will work vs. there are many ways to raise a car), and influences creativity (where can I find a jack? vs. how else can we raise the car?). If you are not looking in the right direction it does not matter how clever you are, you will not see what you need to see. Perception, therefore, seems to offer a pivotal point of leverage for impacting problem representation. It is important to understand what factors influence how an individual perceives a problem and whether or not it is possible to facilitate the perception process in a way that reflects insight into the nature of the problem and consequently promotes both an insightful representation of the problem and an insightful solution.

Processing of Problem Information

Processing of the problem information is mediated by a variety of cognitive and physiological processes that serve to either enhance or constrain the insight problem solving process. How one interprets an event or a problem is the result of infinite factors as seen above and can change from one day to the next. Researchers have illustrated that conciseness of problem representation also varies with 'experience level' in the areas of accounting (Choo & Tan, 1995; Choo & Trotman, 1991; Christ, 1993; Chung & Monroe, 2000; Lehman & Norman, 2006), academics (Gagne et al., 1993), foreign policy (Sylvan & Voss, 1998), and medicine (Bordage, 1994; Boshuizen & Schmidt, 1992; Rickers et al., 2003; Schmidt, Norman & Boshuizen, 1990, 1993;

Van de Weil et al., 2000). Myriad personality, temperament, socio-cultural, and genetic factors may be influencing the mechanism of cognitive appraisal (Cloninger, Przybeck, & Svrakic, 1993; Penley & Tomaka, 2002); Svrakic, Svrakic, and Cloninger (1996) found that their factors of temperament were invariant despite socio-cultural influences. A colleague described how, though he was able to solve a coin problem in his colleague's office, when asked to do so in front of a classroom of students, he was not able to solve it, despite his earlier success that very day. Leverage for changing personal or biological factors impacting appraisal and perception may be elusive due to their sheer complexity and number. However, it is not so much what causes the imposition of cognitive constraints that concerns us, but rather that such an imposition indeed takes place and how it might be possible to resolve imposed constraints or at least navigate past them to a clarified view of the problem.

Exploring information processing mechanisms offers a window into how perception works and what perceptual factors may be influenced to facilitate greater insight. According to the theory of cognitive appraisal, perception is governed by cognitive, emotional and physiological factors. An individual first appraises a situation as threatening or not, then appraises his resources for resolving the threat (Lazarus & Folkman, 1984). If an individual appraises a problem as 'threatening' and then appraises it as 'beyond his locus of control,' he becomes hypervigilant to threat cues, and his attention narrows (Ansburg, 2002; Easterbrook, 1959; Eysenck & Calvo, 1992; Hertel, Mathews, Peterson, & Kintner, 2003; Mogg, Mathews, Bird, & Macgregor-Morris, 1990) resulting in a limited capacity to utilize cues as they are presented and negatively impacting performance (Ansburg, 2000; Baumeister, 1984; Mednick, 1962). In this way, perceived stress has been shown to impact perception and focus.

Attentional Focus

If one is too busy focusing on the obstacles, it is impossible to see the openings. Knoblich, Ohlsson and Raney (2001), in a study of problem solving found that 'gaze' predicted problem solving ability. They concluded that a problem solver's focus (in the case of matchstick problems upon either the number or the operand) was a critical factor in the problem solving process. A threat appraisal can cause the individual to focus unproductively and debilitatively on, among other things, the stress itself (Jones & Swain, 1992, 1995; Jones, Swain, & Hardy, 1993a, 1993b), associated negative emotions, thoughts or images (Hayes, Barnes-Holmes, & Roche, 2001), the step-by-step processes of a task (Wulf, McNevin, and Shea, 2001), or distractions such as the crowd or external expectations (Eysenck, 1992). A threat appraisal can also cause the solver to fixate on premature solutions or representations of the problem, making it difficult to see the problem for what it truly is (Ormerod et al., 2002). Focus offers a point of leverage in facilitating insight.

Facilitating Insight

Positive Interpretation

Accepting or positively interpreting perceived threats appears to free up the cognitive resources required to focus on the task at hand (Bond & Bunce, 2003; Hayes, Barnes-Holmes, & Roche, 2001; Jones, Swain, & Hardy, 1993b; Macleod & Mathews, 1988; Walinga, 2008). However, the mechanism that enables individuals to accept or positively appraise stressors and thereby sustain a more productive focus eludes researchers. Studies in performance and problem solving have demonstrated that focusing on perceived threats diverts attention from goal achievement thereby detracting from performance (Baumeister, 1984; Eysenck, 1992; Hayes, Barnes-Holmes, & Roche, 2001; Jones & Swain, 1992; Wulf, McNevin, and Shea, 2001); however, efforts to focus solely on the goal when a threatening barrier exists have proven ineffective because the act of

replacing the negative with the positive also diverts energy and focus from the task at hand (Baumeister et al., 2001; Beilock, Afremow, Rabe, & Carr, 2001). Focus seems to offer a starting point for facilitating insight but it is difficult to simply 'shift' focus because threat focus overpowers a goal focus. In fact, threatening information receives more processing and contributes more strongly to the final impression than positive information, perhaps explaining the phenomena of 'fixation' and 'rumination' (Dominowski, 1981) – the experience of going over and over a problem in one's mind while lying awake in bed at night. Attempting to override an individual's need to address perceived threats will likely result in resistance (Baumeister et al, 2001). The question arises whether it is possible to influence attentional focus in a way that accommodates or relaxes the strength of a threat focus.

Divergence Training

The emerging challenge for training CPS has been how to facilitate the divergence necessary to cast a wide attentional net, along with the convergence that enables one to choose well among many alternative solutions. Scott, Leritz, & Mumford (2004) performed a meta-analysis of creativity training programs and, based upon 70 studies, found that successful programs were likely to focus on both idea generation (divergence) and cognitive skills training. Chrysikou (2006) found that divergence training with a specific focus on elements of a problem (i.e. how else might one use a matchbox?) helps the solver to reach insight. But, while a correlation may exist between divergent thinking and creativity (Feldhusen & Clinkenbeard, 1986; Harrington, Block & Block, 1983; Mednick, 1959), insight does not appear to be a function of divergent thinking alone. For instance, Fontenot (2001) found that creative problem solving skill depended upon a combination of fluency in data and problem finding (number of ideas and problem representations), flexibility in problem finding (variety of ideas and problem representations),

and quality of problem statement (degree to which the needs and motives were satisfied as established by the owner, goal and constraints of the final problem statement). Divergence applied to the problem representation (Ansburg, 2000) will not ensure an insightful problem representation or that a solution will be found. The ability to think of many ideas, or to link remote ideas, does not necessarily mean one is creative or insightful (Feldhusen & Clinkenbeard, 1986). While a solver may stumble upon an insightful representation of a problem through exercises in divergent thinking, we are concerned with a more intentional process that leads a person more directly to the insightful representation of a problem.

While divergent training programs like Synectics ask for a suspension of judgment, openness and divergence of thinking (Harriman & Mauzy, 2003; Hicks, 1991; Nolan, 1989), the Synectic approach is an imposed open mindedness as opposed to an emergent openness. Not everyone responds to being told to think openly. We have also seen that a threat focus makes such a voluntary shift difficult (Baumeister, 2001). However, most people have the capacity to think openly and thus could be facilitated to open up their thinking processes. In line with all great pedagogical theory, in order to truly understand, a learner must navigate their own path to a solution.

Constraint Relaxation

Theorists argue that the key to facilitating insight and overcoming impasse is constraint relaxation (Ohlsson, 1984; 1992). Constraint relaxation is based on the idea that an impasse can be broken if certain constraints can be relaxed. For example, opening a door is normally subject to the constraint that the door should not become damaged in the process. In an emergency, it might be necessary to relax this constraint and break through a locked door. In this type of situation, problem solving might be less a matter of searching among possibilities than of

redefining what to search for. To break through a locked door in time, one should perhaps search for an axe rather than a key. Knoblich and colleagues (1996) argue that arriving at the need to search for an axe requires that the constraint to avoid damaging the door be relaxed by realizing that it does not matter if the door is damaged. However, it is very difficult to identify constraining assumptions by their very sub-cognitive nature. In fact, the process of relaxing constraints may be more complex than is presumed and may represent the crux of problem solving.

Constraining assumptions seem to be linked to problem representation (I need to unlock this door but I cannot damage the door therefore the problem is finding a key). If one is able to inquire into one's constrained representation (the problem is there is no key) one can reveal underlying assumptions (this is based on the assumption that I need a key to open a door) and the barriers this assumption helps to construct (there is no key). By exploring the constrained representation itself, it may be possible to reveal the problems this representation and resulting barrier pose to one's goal of reaching safety which would help the solver to relinquish assumptions, release from a threat focus, and define the problem in a way that would promote more productive solutions (without a key, the fundamental problem is how can we get through this door?) Therefore problem representation, assumptions, and focus emerge as important factors to explore in this study of insight and creative problem solving.

Cognitive Readiness

A certain amount of cognitive readiness may also be necessary to both seek insightful problem representations and see insightful solutions as they arise. One might argue that the ability to see insightful solutions is predicated upon the insightful representation. Pasteur once said "Dans les champs d l'observation, le hazard ne favourise que les esprits prepares" - "In the field of

observation, chance favours only the prepared mind" (Vallery-Radot, 1939). The American physicist Joseph Henry (1797-1898) echoed this axiom when he said "the seeds of great discoveries are constantly floating around us, but they only take root in minds well- prepared to receive them." How many others alongside Newton had also witnessed an apple fall from a tree? The problem must be represented in such a way that the solver is not only generating viable solutions but also 'ready' to see the sustainable solution as it emerges (Seifert et al., 1995). Ohlsson (1992) extends the definition of insight to one of 'full insight' which consists of the breaking of the impasse plus the completion of the entire solution in the mind's eye. Ohlsson points out that sometimes solvers continue to struggle even after breaking the impasse or cognitive constraint. Ormerod and colleagues (2002) show how, 'even when a move capture(d) the conceptual insight necessary to solve the problem', the solver would often return to the original constrained thinking (p. 798) further supporting the power of threat focus and 'fixation'. In this case the impasse is broken accidentally or without the awareness of the solver. Such a concept points to Ormerod and colleagues' (2002) suggestion that a certain level of preparedness is necessary for full insight to occur: the solver must be ready to see that an impasse has in fact been broken and that a whole new realm of solution possibilities are available. Ohlsson, Ormerod and colleagues add to the case against divergence applied to problem representation suggesting that the solver must be intentional in their representation of the problem in order to recognize that an impasse has been broken.

Solvers must also be ready to restructure their problem representation. Navigating one's way past imposed constraints may demand a certain 'letting go' of assumptions about the nature of the problem itself. Perhaps the problem finding process may be more accurately described as

a route finding process as well as a root finding process, in that we must navigate a pathway through the perception process to a more fundamental representation of the problem.

Failure

The mechanism whereby one might become ready to restructure a problem representation may exist within the problem itself. Ormerod and colleagues (2002) point to an unusual approach: failure. Ormerod and colleagues (2002) suggest that meeting with failure can inspire the solver to look for alternative solution paths, or 'let go' of their fixation on a pathway that is ineffective. With failure, individuals may be driven to restructure the initial representation of the problem and open up their attentional focus. Gary Klein (1996), in his work on non-linear problem solving, also proposes that possibilities for solution reside within failure for "as options are generated and rejected, the reasons for the failures will suggest ways of changing the course of action, while at the same time changing the way the goal is perceived" (p. 199). MacGregor and colleagues (2001), and Knoblich, Ohlsson, Haider & Rhenius (1999) suggest that experiencing 'criterion failure' may induce an impulse to 'seek alternatives' while creating 'a state of preparedness that disposes the solver to attend to solution-relevant information'. However, if a state of mental readiness is necessary for capitalizing upon novel, solution-relevant information, while it is suggested that 'repeated failure' can serve to relax constraints, unless the underlying mechanism of appraisal causing constraints is changed, the solver may simply impose new constraints (i.e. we must find something *like* a jack to fix a flat tire). It is not clear in either of these studies how or whether criterion failure serves to generate a 'state of preparedness'.

Intriguing is the concept of solution within failure. Perhaps within failure, the problem presents itself again and demands a fresh approach or at least forces the solver to re-evaluate the true nature of the problem. In the case of the flat tire, having no recollection of a service station

would mean criterion failure, offering a prime opportunity to not only restructure but to reevaluate the fundamental problem. The group might simply look for other ways to find a jack, or they might ask 'Why do we need a jack anyway? What else could we use?' Criterion failure may not only signal the 'need to abandon the current operator and to search for an alternative operator', but may also reveal the root problem. It may be most possible to facilitate a shift in problem perception and representation at the point of failure because the threat becomes hopeless and no longer worth focusing upon. Simply asking people to reconstruct the problem without facilitating an actual shift in cognitive bias or focus may result in a construction still focused on the threat (i.e. 'where else can we get a jack?' or 'how can we make a jack?') Shifting representation of the problem can occur by exploring actual threats and not only serves to restructure the problem representation, but does so free of constraints: 'what if there is no jack?' 'what is the problem this creates?', the answer being 'because we need to lift the car in order to change the tire' which is the insightful problem representation. If there had been no way of getting a jack, the group would have met with criterion failure and would have been forced to accept 'no jack' as a reality rather than as a problem. Accepting the barrier as a reality in turn leads to a new focus of 'what problem does this barrier pose to the original goal of this problem?' and a new problem representation of 'how to lift the car without a jack.' Once the group constructs the problem in this new, more penetrating manner, they are mentally prepared to 'see' the barn and all of the 'lifting' possibilities held within it. In this way, the threat focus can act as a pathway to the 'more penetrating view' of the problem, relaxing constrained thinking and facilitating the cognitive readiness to both re-represent the problem and see insightful solutions.

Helping the solver to see that representing the problem as barrier leads to failure, and then using that barrier as a pathway to a new representation of the problem may increase capacity to process problem information and activate prior knowledge (Eubanck, Collins, & Smith, 2000; Eysenck & Calvo, 1992; Mogg, Mathews, Bird, & Macgregor-Morris, 1990). The key to removing constraints upon problem representation may lie within the constraints themselves. Therefore, along with the concepts of prior knowledge, perception, information processing, and attentional focus this study explored factors of cognitive readiness, barriers and failure as they relate to problem solving and insight.

DISCUSSION

The key to the cognitive shift required to achieve insight seems to be both a root and route finding process. It is important not simply to return the solver to the root problem, but to help them navigate the various assumptions, constraints, and appraisals that they naturally make during the problem solving process in a way that leads them to both an acceptance of perceived barriers and a view of the root problem or an 'integrated focus'. In fact, a perceived barrier may elucidate the root problem for a problem solver. We propose that the pathway to creative insight involves the following cyclic stages:

a) Primary and Secondary Appraisal (using prior knowledge)

b) Initial Focus and Representation (barrier or problem focused)

c) Solution Generation (impasse or insight)

d) Re-appraisal (of result and resources)

e) Re-focus and Re-representation (barrier, non, integrated)

f) Solution Re-generation (impasse, insight, or stuck)

FIGURE 1: Problem solving pathways

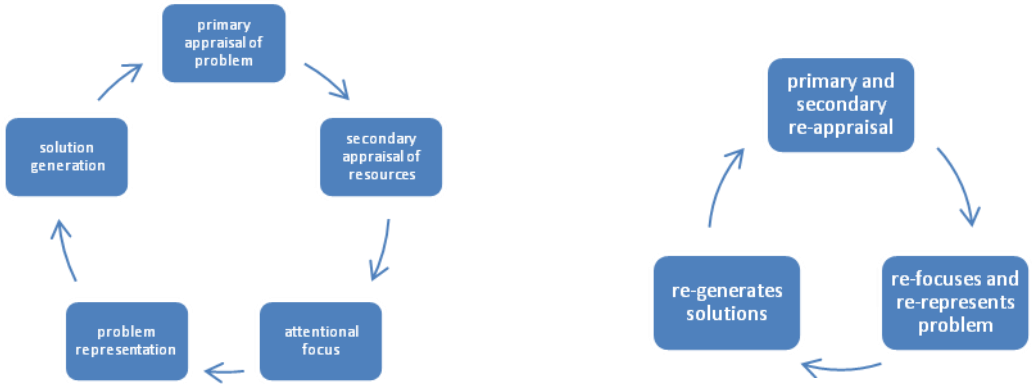


Figure 1 illustrates and describes the proposed insight process. In the first cycle, the solver primarily appraises the problem (i.e. is this a problem?), draws on prior knowledge and assumptions as part of secondary appraisal of the problem (i.e. I've seen this before… this means… I usually), initially focuses and represents the problem in a constrained (i.e. therefore the problem must be…) or unconstrained manner (i.e. I've never seen this before… what is the problem?), generates solutions and either meets with a barrier due to constrained thinking (i.e. but this solution isn't working!) or attains insight (i.e. aha!). In the second cycle, if the solver meets with a barrier, she then moves into the first cycle again and re-appraises the result and her resources. At this point, she may appraise the barrier as threatening or non threatening. If she appraises the barrier as threatening, she will continue to attempt to overcome it. Is she accepts the barrier as non threatening, she is able to consider the barrier as a reality and consider the problems it poses to the initial goal or challenge. If she appraises her lack of ability to overcome the barrier as threatening, she will attempt to increase her ability and 'try harder' to overcome the barrier. In this way she re-focuses and re-represents the problem as either the barrier (i.e. this is the only way, I have to make this strategy work!), or a lack of solution / lack of ability (i.e. this isn't possible! I suck! I need to try harder), or a need to refocus (i.e. this doesn't seem to be

working, there must be another way to make this work), or the problem the barrier poses to the goal (i.e. this doesn't seem to be working… if I can't do this, what's the real problem?)

The Nature of Insight

Our conceptual model proposed that the cognitive mechanisms of appraisal and focus determine readiness to both seek and see insightful solutions, resulting in either a state of insight, impasse, or being stuck. At the point of impasse, the individual cycles through the phases having either a) re-focused and restructured the problem representation or b) retained the same problem representation but with renewed vigour or c) reached a point of complete failure or 'stuckedness'. Being stuck describes the state an individual reaches in which they 'give up' or throw up their hands in defeat because they see no alternative. At times, impasse seems to facilitate further restructuring and insight by causing individuals to accept and move beyond their barrier representation of the problem; at other times impasse leads to renewed efforts to overcome the barrier. Because overcoming the barrier is usually unsustainable or impossible, this avenue eventually leads to re-representation or a state of being stuck. For instance, after 'pushing through several injuries' an individual may become exhausted and have a complete physical breakdown. The breakdown may lead to a restructuring, insightful representation of the problem, and more integrated focus (i.e. what problems does my inability to work create for me and how can I solve these given my injured status?) The breakdown may also lead to a feeling of being stuck (i.e. I am useless).

It appears that threat appraisal plays a role in how strongly an individual clings to their constrained representation and barrier focus. If the barrier is perceived as very threatening then the tendency would be to focus on the barrier with great intensity. Asking a person to let go of the barrier would be unproductive since attempting to override the individual's need to address

perceived threats will likely result in resistance (Baumeister, 1984; Baumeister et al, 2001). In order to facilitate a more integrated focus, it may be necessary to 'drill down' through the constrained representation or 'unpack' the barrier to better understand what problems it poses to the original goal of the problem. Unpacking the barrier exposes, clarifies and elucidates the individual's actual challenge or goal. Utilizing the barrier as a pathway to a more goal oriented representation of the challenge still enables the individual to address the threatening nature of the barrier while moving toward a new, more productive representation of the challenge. Understanding what goals the barrier is threatening will serve to represent the problem more insightfully.

Checking assumptions can be helpful, but it is also important to see the constraint one has set up because of the assumption. "Perspective transformation is the process of becoming critically aware of how and why our assumptions have come to constrain the way we perceive, understand, and feel about our world; changing these structures of habitual expectation to make possible a more inclusive, discriminating, and integrating perspective; and, finally, making choices or otherwise acting upon these new understandings" (Cranton, 1994, p. 22). While assumptions may well impact and constrain cognitive processing on ill defined problems (Bowe et al, 2003; Schommer, 1990), checking assumptions, though important, may not always realistic.

Researchers have found that solvers would at times represent the problem correctly but would be unable to generate creative solutions. At this point, a brainstorming intervention may help. Presently, creative problem solving strategies focus on generating creative solutions to a problem at the outset. While it is possible to intuitively arrive at a problem representation or an insightful solution, such a strategy is unreliable and at times the problem solver seems

'surprised' when arriving at the answer. While it is possible to 'stumble upon a solution' it is just as easy to stumble past it. Divergence and openness can be helpful to the problem solving process, but alone creativity exercises and strategies are not enough to ensure an insightful solution. Creativity may not be productive or purposeful until after the problem has been represented correctly and focus has been recomposed to include both the barrier and the goal. It is not enough to simply see the solution or see the problem, one has to be ready to see solutions due to a clear representation of the problem, or ready to see and pursue the problem due to confidence in personal resources. At this point of insightful representation of the problem, it is believed that creativity exercises such as divergent thinking and brainstorming would be most effective.

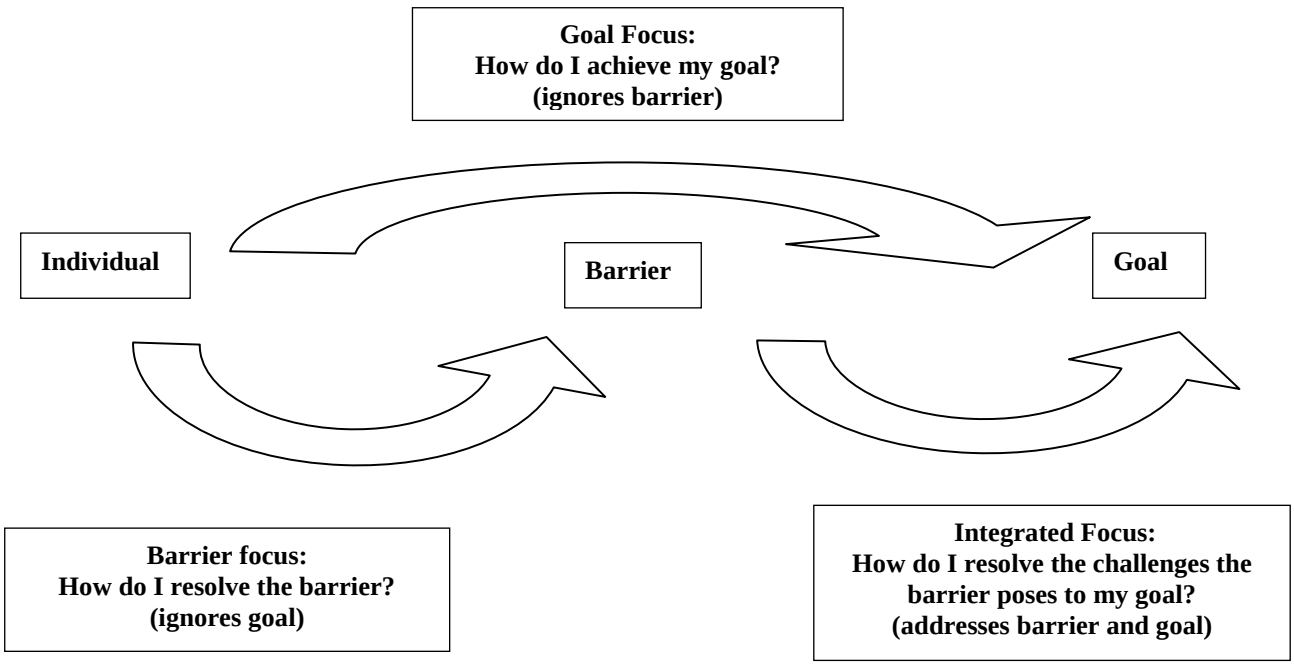
One further theme emerging is the idea that each individual must follow their own path to the solution. A certain level of failure seems to be necessary before solvers are willing to move on or release a strategy that was not productive. Solvers perhaps need to recognize the failure of their solutions before they are willing to attempt other solutions or recognize the barrier as a barrier rather than as the actual problem. Some solvers may be unable to accept failure. For instance, even when it is clear that a strategy will not work, some solvers may continue to try to make their strategy work. Perhaps in time, they would come to recognize the immovability of these barriers, reach an impasse, accept the barrier, and reconstruct the problem more insightfully. Perhaps a certain level of self efficacy (belief in one's ability to and resources for addressing a challenge, Bandura, 1980; Lazarus & Folkman, 1984) is required in order for individuals to let go of uncontrollable threats. Such individuals may be better able to tolerate a level of uncontrollability because, though they do not necessarily know what alternative solutions exist, they are confident in their ability to generate 'some kind of alternative solution

somehow.' Alternatively, perhaps a high internal locus of control leads such an individual to believe that 'there must be some way to make this work.' Opportunities for leverage are limited, however, for it is difficult to change or enhance self efficacy or locus of control especially when under time constraints posed by an athletic, professional or academic challenge. The present research suggests that manipulating focus may be a more productive avenue for facilitating problem solving outcome.

Promoting Insight

In order to 'drill down' or 'unpack' perceived barriers and the threats associated with these, the question: "what problems does this barrier pose to your overall goal?" would appear to offer leverage for clarifying the actual goals that the barrier is threatening, thereby clarifying the actual problem. Unpacking the threat both addresses perceived threats and generates a pathway to the goals that the threat threatens, bypassing constrained thinking and the barriers that constrained thinking constructs as illustrated in Figure 2.

FIGURE 2: Achieving an Integrated Focus



In the example of the Mann Gulch fire from our introduction, only Dodge was able to appraise the barrier that they could not outrun the fire as a reality, not a threat. He re-represented the problem as the challenge this reality created for him: the prospect of being consumed by the fire. His younger crewmembers remained focused on the barrier. For them the problem became escape (how can we run faster? How else can we escape?) causing them to lose sight of the root problem of how to avoid burning. Appraising the barrier as reality rather than a threat perhaps allowed Dodge to focus upon the goal of survival and the need to remove fuel so as to reduce the chance of being burned by the fire.

Knoblich and colleagues (2001) prefer the hypothesis that "initial representations are inappropriate or misleading rather than incomplete, and thus have to be deactivated or inhibited rather than extended or elaborated" (p. 10), but the present study would argue that rather than turning one's gaze from the barrier and 'deactivating or inhibiting' a representation, it would be more productive to follow one's gaze from the barrier to the goal, creating an integrated focus and insightful problem representation. Klein and Weitzenfeld (1978) proposed the importance of identifying the properties of the goal, and simultaneously attempting to find procedures for accomplishing the goal in their work on ill defined problem solving. The current study proposes that by penetrating the barrier, one arrives at the goal while keeping the barrier in view generating a more integrated representation of the problem, and subsequently unlocking more creative and relevant solutions. It is hypothesized that an integrated focus would enhance problem solving ability and outcome on a variety of problem solving tasks.

CONCLUSIONS, LIMITATIONS AND FURTHER RESEARCH

The purpose of the study was to explore the nature of the insight problem solving process. A more integrated focus may serve to enhance performance by attending to the challenges a barrier poses to a goal while sustaining a goal focus overall. The conceptual model of insight presented here enlarges the theory of problem solving by proposing that prior knowledge and cognitive appraisal constrain thinking and lead to an initial representation of the problem as a barrier or threat (i.e. the fire is coming, it's going to burn me, therefore I must escape it). Secondary appraisal determines whether one has the resources to overcome the threat (i.e. can I outrun it?). If one does not have the resources to overcome the threat, the problem becomes creating the resources. This shift in attentional focus from the actual problem to perceived threat constrains problem representation to one of a threat focus limiting the definition of the problem to that of 'escape' and narrowing solutions to only those that have to do with escaping. If the solution does not work, it becomes a barrier. The process of appraisal, representation and focus begins again. If the barrier is perceived as threatening, a barrier focus intensifies. The current study makes recommendations for facilitating insight suggesting that perceived threats when explored or followed leads the solver to articulate the problem the barrier poses to the original goal which facilitates an insightful representation of the problem and increases the odds of an insightful solution.

The results, though preliminary, indicate that it is important for future researchers to explore the roles that appraisal and focus play in the problem solving process, specifically as these factors influence problem representation. It is difficult to generalize from such specific samples suggesting that future researchers expand the inquiry into a wide array of problem scenarios in both lab and field settings. Further research is also necessary to identify the mediating variables accounting for the tendency of human beings to fixate on barriers or barrier

focused strategies. Studies to explore the roles of perceived control, appraisal and attentional focus, including a broader sample derived from a variety of problem solving and performance scenarios, would further elucidate the topic. More specifically, research to explore the negative effects of internal locus of control under objective uncontrollability would serve to expand understanding of the role that stress appraisal and perceived control plays in the problem solving process. Finally, the results of this study encourage a quasi experimental study testing an intervention designed to help individuals develop an integrated focus when problem solving.

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