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"Evaluate Our Understanding of the Processes Involved in Creative Thought"

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Introduction

Creativity is as difficult to define as it is to study with ecological validity. Robert Sternberg provides a brief cognitive definition in his Handbook of Creativity, “Creativity is the ability to produce work that is both novel..and appropriate.” (Sternberg, 1999). Historically the mystical paradigm established in classical Greece attributed the act of creation to divine inspiration, anthropomorphised in the figure of the muse**.** Throughout the twentieth century a multiplicity of mutually exclusive perspectives on creativity emerged. Contributions outside the field of psychology included the pragmatism of Edward De Bono (1970), focusing on the development of techniques to foster creativity, and the application of Freudian Psychodynamic theory, explaining creativity as an expression of the sublimation of infantile sexuality. (Freud, 1908, cited by Arieti, 1976).

Scientific psychology too has taken a variety of perspectives on creative cognition. Psychometric tests such as the Torrance Test of Creative Thinking (Torrance, 1974) attempt to comparatively measure and quantify the process of creativity in individuals classed as both normal and creatively gifted. Social psychologists have attempted to assess the impact of cultural, domestic, inter and intrapersonal factors on the development of creativity within the individual (Montouri, 1997). Evolutionary psycho-biologists have applied Darwinian principles to the propagation of creative ideas (Blackmore, 1990), and argued that the function of creativity is to acquire social status (Pinker, 2002), or impress a potential mate (Miller, 2000, cited in Pinker, 2002).

Conversely cognitive psychologists have focused not on the purpose behind creativity, but on the processes involved in the production of unique or highly esoteric ideas; constructing computational models of the creative process, and attempting to relate it to the more mundane aspects of problem solving. A distinction is drawn in the literature between the processes involved in creation, and models describing the functioning of creativity. As this distinction is relatively arbitrary when dealing with computation models which by necessity must model processes in order to model theoretical structures I will discuss both of these cognitive research streams within this essay; evaluating some of the competing models of creative cognition and the processes which underlie creative thought.

Problem Solving and Problem Space

The pre-eminent account of problem solving from a cognitive perspective is the Problem Space theory (1972), elaborating on ideas originally modelled in Newell and Simons General Problem Solver (1958), problem space has been highly influential both in the growth of computational modelling as a whole and problem solving research in particular. (Eysenck & Keane, 2002).

Problem space theory breaks problems into a series of states; an initial state, intermediate sub-goal states, and a goal state. Problem solvers search the ‘problem space’ of these states using their existing knowledge and heuristics (generalizable rules for performing cognitive tasks), and move between them with mental operators (functions containing allowed and forbidden moves between states).
However a profound difficulty exists in applying this or similar models of problem solving to creativity. Creative problems may have ill defined initial states, as in the development of manned flight, where the mechanism necessary was not clear, or poorly defined or absent goal states, for example in literary fiction or abstract painting.
Additionally cognitive problem solving research has accounted for the greater skill with which some individuals solve problems by studying experts in the fields of chess, physics and computer programming, and deducing that their greater ability is a function of their possession of greater expert knowledge. This expert knowledge allows the formation of more elaborate schemata and the more effective encoding of problems (Green & Gilholy 1992, cited in Eysneck & Keane, 2002). However this account, although an effective explanation of the skill of experts, fails to account for the many unique features of creative individuals. Highly creative and influential scientists for example, tend to produce their most important discoveries in the early stages of their careers. At this point they do not possess the greatest expertise in their area of specialty nor as much knowledge as they may later accrue. Indeed an inverse correlation may exist between age and originality in many creative individuals (Simonton, 1996)**.** Finally problem space theory fails to account for individuals of genius, who produce work which is not only highly original but which could not have been produced within an existing paradigm; nor for savants syndrome, a phenomenon which infrequently occurs in autistic individuals. Savants (representing 10% of autistic people) are individuals who while possessing learning difficulties, simultaneously have an aptitudes far greater than average in a specific field, while not necessarily possessing advanced specialist knowledge (Silberman, 2003).

Models of Cognition

Cognitive researchers have rejected the traditional exclusive model of an innately and uniquely creative minority (Howe, Davidson, Sloboda, 1998, cited in Eysenck and Keane, 2002), attempting instead to identify the processes underlying all creativity from the common place to the highly adept. One aspect of this research has been the application of cognitive principals to the gestalt psychologist Wallas’s description of the stages of creative thought. This consists of preparation, the initial attempts at the solution of the problem; followed by incubation, where the problem is ignored or forgotten; illumination, an instant clarification of the solution; and verification, where the solution was checked and found to be correct. Although Wallas’s account has been influential in the study of creativity, it was based on a small number of qualitative autobiographical accounts. (Wallas, 1926, cited in Eysenck and Keane, 2002). Wallas's framework has been fitted into problem space theory by classifying the information discovered in preparation into either control (or meta-data) and factual information. Control information more rapidly fades from memory during incubation, leaving factual information available to be utilised in the formation of novel sub-goals, or combined with fortuitous environmental cues (Lubart, 2001).

More recently two cognitive models, Improbabilistic versus Impossibilistic Creativity (Boden, 1991, cited in Eysenck and Keane, 2002) and the Geneplore model (Finkle, Ward and Smith, 1992, cited in Eysenck and Keane, 2002), have examined creativity from a cognitive perspective.

Improbabilistic creativity obeys the constraints of the existing conceptual space of ideas, creating unusual analogies of existing concepts. Impossibilistic creativity by contrast alters the rules of conceptual space, creating ideas impossible within the previously existing framework (Eysenck & Keane, 2002).

A more developed model of creativity is Finke, Ward, and Smith's Geneplore (Generative-Explorative) model. This model divides the process of creativity into two phases. A generative phase, in which mental representations of the problem are created, and an exploratory phase in which the properties of these mental representations are manipulated.

This model was tested by Ward, 1992, who tested subjects ability to produce novel alien forms, and discovered a tendency to produce modified earth like creatures, as predicted by Finke, Ward and Smith's model (Eysenck & Keane, 2002). It is important to note that while the Geneplore model adequately encapsulates Improbabilistic creativity, it does not provide a framework in which Impossibilistic creativity, as defined by Boden can occur.

Mental Models and Analogy

Much cognitive research in the area of creativity has been concerned with specific processes involved in creating new concepts. Mental models (also known as naïve models), simulations of various problem states or states in the world, have been investigated as one way in which humans think counterfactually. McCloskey, cited in Eysenck & Keane, 2002, has investigated the role of mental models in contributing to poor predictions of pen and paper object motion tests; theorising that rather than applying knowledge of Newtonian psychics we tend to rely on an intuitive impetus model of motion. This analysis has been disputed by several experimental studies, which have discovered that subjects performance is more successful if problems are placed in more everyday contexts (Eysenck & Keane, 2002). Yates has theorised that rather than relying on generic mental models resembling Plato's ideal forms, participants envision prototypical re-enactments, visualisations of the motion to be predicted, reliant for their veracity on the familiarity of the activity modelled (Yates et all 1992, cited in Eysenck & Keane, 2002).

Analogy, the mapping of a base set of concepts (domain) onto a target (relationally similar) conceptual framework, in order to extend understanding of the base concept, as a key creative methodology has been widely studied by cognitive psychologists such as Keane, 1997. Two processes must occur for an analogy to be made, a related domain (or analogue) must be discovered, and then mapped onto the target domain.

Gentner, Ratterman, and Forbus 1992, quoted in Eysenck & Keane, 2002, found that subjects tended to utilise superficially similar analogies, ones in which the apparent situations presented matched rather than the fundamental relational aspects of the problems. This is possibly due to the difficulty of recalling an apparently different situation which relationally correlates to the problem being solved (Eysenck & Keane, 2002).

As computational modelling has developed, several competing models of the development of analogies have been developed, including the Structure Mapping Engine (SME), the Incremental Analogy Machine (IAM), and Learning and Inference with Schemas and Analogies (LISA). Whereas previous computational models of analogy mapped only syntactic elements, structurally similar information, or pre-programmed and extracted semantic information; LISA, a hybrid semantic connectionist network, breaks data down into semantic units, which are then be matched for meaning rather then superficial structure (Baker, 1997). This provides a working model of some of the meaningful but remote associations humans make through analogy.

Conclusion

While enormous progress has been made in the study of creative problem solving, from the computational modelling of our use of creative processes such as metaphor and in particular analogy, and in of the operation of Improbabilistic creativity, the lack of research into Boden’s impossibilistic creativity by cognitive scientists probably represents more the difficulty of studying this concept in operation than its absence.

Throughout human history discoveries have been made which were quantitively different from what had gone before, from the domestication of animals to the use of perspective in art; and individuals like Shakespeare and da Vinci have emerged who produced creative work which far exceeded in originality and accomplishment that of their contemporaries (Shlain, 1999). Additionally, cognitive psychologists have failed to account for differing creative aptitudes, psychometrically measurable characteristics in the same sense as I.Q or personality types; none of which are explainable as aspects of expertise.

The ultimate test of cognitive computational modelling, must remain the construction of a working model which accounts for all aspects of human creativity, and is capable of explaining and performing the same creative leaps we show in the even simplest of puns. A computational model strong enough to semantically comprehend and construct contextually meaningful information in words in sentences, sentences in paragraphs, and ultimately pages in books; to say nothing of modelling human creative ability and in the visual and auditory realms.

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