CREATIVE INFERENCE IN IMAGERY AND INVENTION

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ABSTRACT

By constructing images called preinventive forms, and by exploring the various interpretive possibilities afforded by those forms, a person can discover a new invention, develop a new concept, or gain new insights into how to solve a problem. Recent studies show how imposing different types of constraints on interpreting these forms affects the likelihood that a creative inference can be made. These findings have important implications for current efforts to develop creative forms of artificial intelligence.

INTRODUCTION

Recent work in the field of imagery has demonstrated that people are able to recognize various patterns that emerge when they form a mental image, even when the patterns could not easily have been anticipated (Finke, 1989; Finke, Pinker, and Farah, 1989). Such findings provide experimental evidence that people can make unexpected discoveries when they mentally combine an object's parts and features. This leads naturally to the question of whether it might also be possible to demonstrate, under controlled experimental conditions, that people can interpret their images in ways that result in new ideas for inventions or creative concepts.

PREINVENTIVE FORMS

In the experiments I will describe, which are taken from Finke (1990), subjects were instructed to generate mental images called preinventive forms. These were mentally constructed using sets of three randomly-chosen object parts, shown in Figure 1. The parts could be combined in any way, their size could be varied, and they could be made out of any material. The only restriction was that the parts could not be deformed, with the except of the wire and tube, which were defined as bendable.

Instructions were given that the forms should correspond to general, interesting shapes, and not to any particular type of object. Examples of preinventive forms are shown in Figure 2. These forms displayed a variety of properties that contributed to their usefulness in creative exploration, such as novelty, ambiguity, and the emergence of unexpected features.

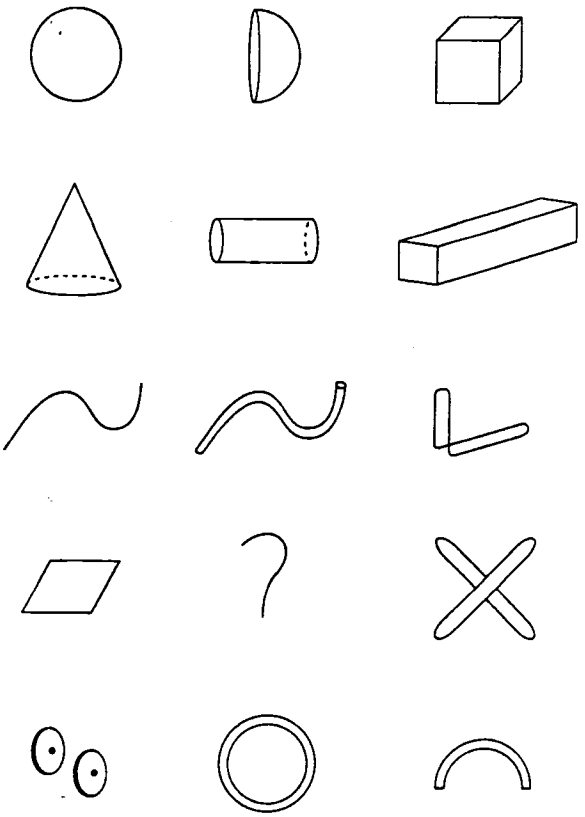

Figure 1. Object parts used to generate Preinventive Forms.

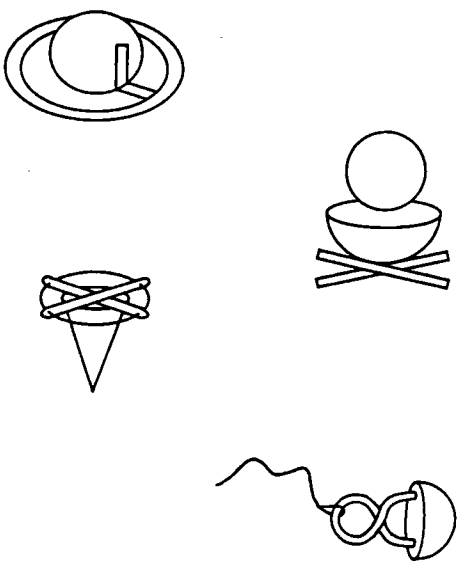

Figure 2. Examples of Preinventive Forms.

CREATIVE INVENTIONS AND CONCEPTS

The subjects were instructed to interpret their preinventive forms as representing some kind of practical object or device, corresponding to one of eight general object categories, such as "furniture," "tools and utensils," and "toys and games." The experiments varied whether the categories could be chosen by the subjects, were specified randomly in advance, or were specified only after the subjects had completed their preinventive forms. The resulting inventions were rated on originality and practicality, and these ratings were used to classify the objects as creative inventions.

The greatest number of creative inventions were obtained when the subjects did not know what the interpretive category would be at the time they generated their preinventive forms. This suggests that, in trying to use imagery to come up with a creative idea, it may sometimes be better to suspend interpretive knowledge until after the image is formed. Other findings showed that the interpretive categories should not be restricted too narrowly; when the particular type of object was restricted, for example, fewer creative inventions were obtained than when the general object category or its function were restricted.

Even though they were given only one minute to generate and interpret their forms, the subjects were able to discover a creative invention on an average of one out of every six trials, in the case where the general object category was specified after the preinventive forms were generated. When extended time was provided to explore the preinventive forms, it was possible to discover a creative invention of some kind on virtually every trial. Additional studies showed that the same preinventive form could be interpreted as representing different inventions across the various categories, illustrating the range of possible interpretations that the forms could inspire.

Extensions of these experiments have demonstrated that preinventive forms can also be interpreted in more abstract ways; for example, as visual metaphors representing creative concepts. Subjects were given general topical categories such as "medicine" and "architecture," and were instructed to interpret their preinventive forms as representing an abstract idea or concept pertaining to the category. Although this was more difficult than the creative invention task, the subjects were still able to discover creative interpretations, and generated a creative concept on about one out of every 12 trials.

These experiments show that it is possible to investigate, empirically, some of the cognitive processes that are actually used in creative discovery, and to identify the kinds of inferential constraints that maximize the likelihood of achieving a creative insight.

IMPLICATIONS FOR ARTIFICIAL INTELLIGENCE

These findings have important implications for efforts to develop creative forms of artificial intelligence. They suggest, for example, that it would be possible to develop computers that could generate novel types of preinventive forms, recognize when a preinventive form would correspond to a useful object or would serve as a useful analogy, and provide novel conceptual interpretations of the forms. In addition, because the same types of processes would apply across many different domains, this work could lead to the development of artificial intelligence that would be capable of more general and universal forms of creative inference.

One example of a general model that can describe creative inference using preinventive forms is the Geneplore model, proposed by Finke, Ward, and Smith (in press). The structure of this model is illustrated in Figure 3. The model makes a general distinction between generative processes, such as mental synthesis, and exploratory processes, such as functional and conceptual inference. The creative process begins by generating a preinventive structure, which may or may not be conceived with some particular goal in mind. Exploratory processes are then applied to the structure, which are guided by various constraints restricting the types of inferences that can be made. The resulting concept may then be refined or expanded by generating a modified preinventive form and repeating the Geneplore cycle.

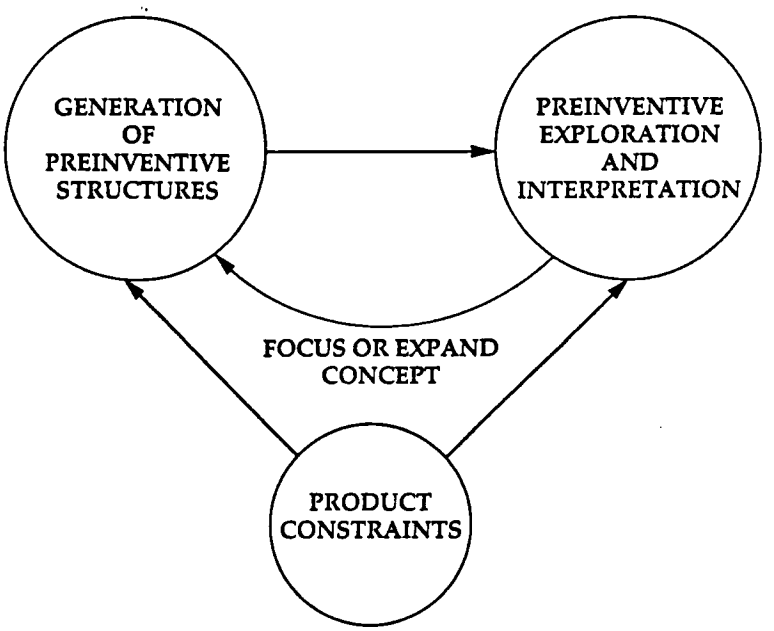

Figure 3. Structure of the Geneplore Model.

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